

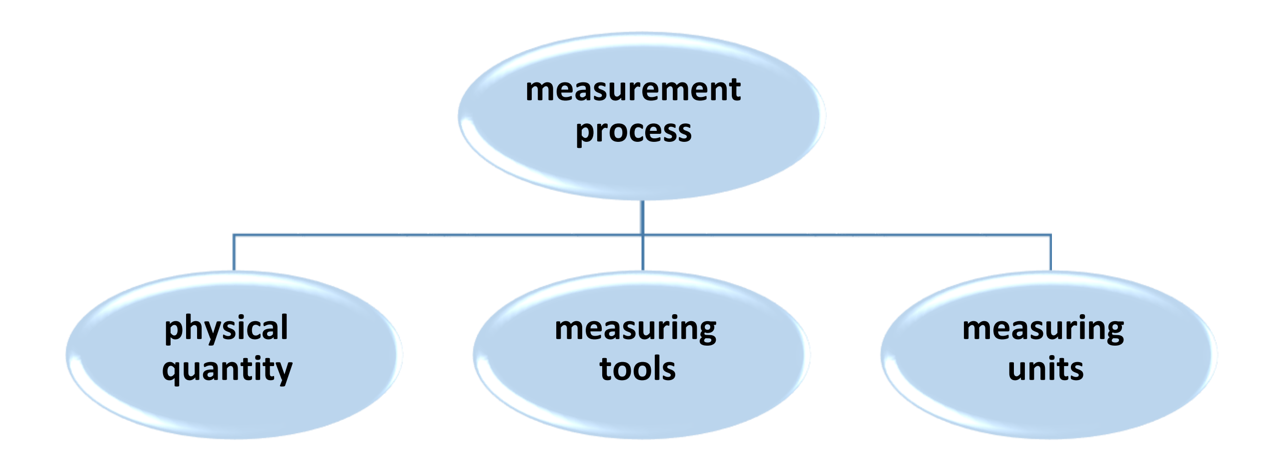
Egyptian pioneer School- languages

Physics
First secondary 2023 -2024

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Physical measurements

*measurement process:it's the process of comparing an unknowing quantity with another known quantity of it's kind to find out how many times the first includes the second



1) Types of physical quantities

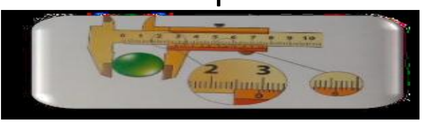
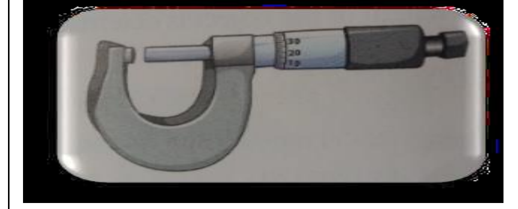
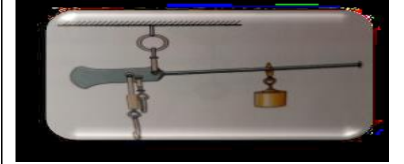
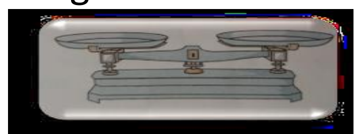
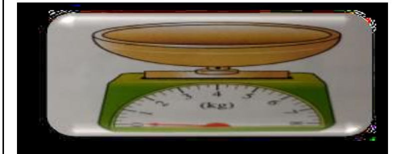
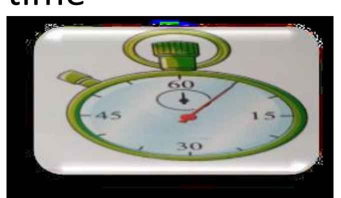
Fundamentalphysical quantities	Derived physical quantities
they are physical quantities that cannot be defined in terms of other physical quantities	they are physical quantities that cannot be defined in terms of the fundamental physical quantities
Ex:length-mass-time	Volume-speed-acceleration

2)Tools of measurement

Ancient:length--->arm,hand,food

Time--->sunrise,sunset and moon phases

recently

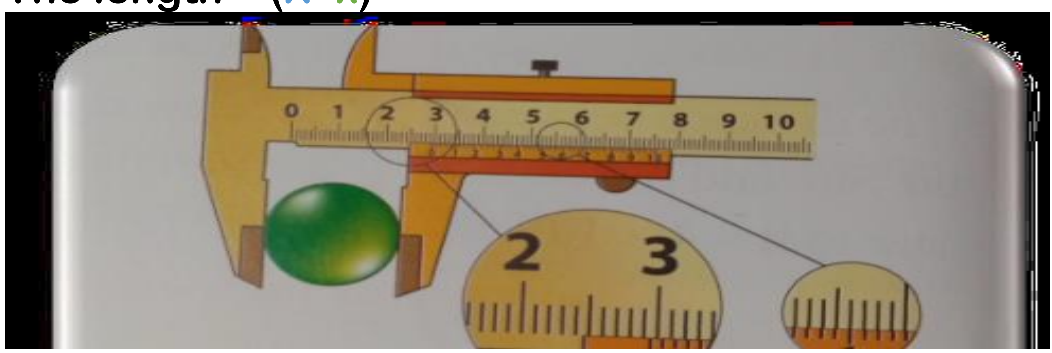
length	mass	time
1-meter tape ->suitable for lengths such as dimensions of room  vernier caliper->suitable for small lengths such as the diameter of pen  2-Ruler->suitable for lengths such as length of book  3-Micrometer->suitable for very small lengths such as thickness of apaper 	1-roman balance: it is used in ancient times but it has alarge percentage of error  2-Two pan balance It measureing in kilogram  3-One pan balance: measuringin kilogram such as measuring the mass of fruits  4-Digital balance:measuring very small masses such as golden accessories 	1-hour glass->oldest tool to determine time  2-Stop watch->measure a certain interval of time  3-Pendulum Clock->depend on energy conservation law  4-Digital watch->newest tool used in our daily life 

How to use vernier ??

1)measure the reading of fixed scale (X) 1mm; use zero of sliding scale (Where the number that facing zero is the reading)	2)measure the reading of sliding scale (x) 0.9mm; use fixed scale (the line on sliding scale lines up to fixed scale)

*Note that the reading of sliding scale(* 0.1)

The length = (X+x)



The reading of this vernier : (X) = 2.9 cm = 29 mm , (x) = 6 *0.1 = 0.6 mm

The diameter of vernier = (X+x) = 29+0.6 = 29.6 mm

3)Measuring units

A physical quantity without its unit is meaningless

	The french system (C.G.S)	The british system (F.P.S)	The metric system (M.K.S)
Length(l)	Centimeter(cm)	Foot(ft)	Meter(m)
Mass(m)	Gram(g)	Pound(lp)	Kilogram(kg)
Time(t)	Second(s)	Second(s)	Second(s)

*international system of units(SI units)

The physical quantity	The international units
1-Length(l) 2-Mass(m)	Meter(m) Kilogram(kg)

3-Time (t)	Second(s)
4-Electric current intensity(I)	Ampere(A)
5-The absolute temperature(T)	Kelvin(K)
6-Amount of material(n)	Mole(mol)
7-Luminous intensity(I_v)	Candela(cd)
8-Angle measure	Radian(rad)
9-Solid Angle measure	Steradian(sr)

Standard(length)meter

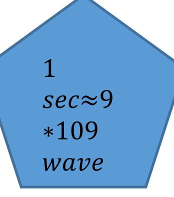
It's the distance between two engraved marks at the ends of a rod made of platinum and iridium alloy kept at 0^0C

The standard time (second)

in encient : use day and night time
Solar day 24 hour , hour =60 min , min = 60 sec

The second =1\86400of the average solar day

Now : atomic clocks (cesium clock)



cesium clock used for :

1)determining the duration of the earth spin .
2)checking up for aviation and navigation .
3)verifing the journey schedule of space ships that explore the universe

The standard mass(kilogram)

It is the mass of culinder made of platinum and iridium alloy of specific dimentions kept at0^0C

***give reason for:**

Platinum and iridium alloy used in standard unit instead of other materials such as glass?

Because 1-it is a rigid 2-chemically inactive 3-not affected by surrounding temperature contrary to other materials

Multiplies and fractions of units

multiply

$10000000000 = 1 * 10^{10}$

fraction

$0.0000000001 = 10^{-10}$

prefixes

prefix	centi	milli	micro	nano	pico	tera	Giga	mega	kilo	hecto
factor	$\times 10^{-2}$	$\times 10^{-3}$	$\times 10^{-6}$	$\times 10^{-9}$	$\times 10^{-12}$	$\times 10^{12}$	$\times 10^{9}$	$\times 10^{6}$	$\times 10^{3}$	$\times 10^{2}$
Symbol	C	m	Ɥ	n	p	T	G	M	k	H

Liter (L)	$10^{-3} m^3 = 1 cm^3$
Angstrom(Å)	$10^{-10} m$
Gram(gm)	$10^{-3} kg$
Ton(ton)	$10^{3} kg$
Femto (fs)	$10^{-15} sec$

The steps of conservation of units:

(1) if unit aren't raised to a power:

Convert the quantity to it's international unit then to the required unit
(2)if a units are raised to a power:
Convert the quantity to it's international unit by raising the conversion coefficient to the same power then to the required unit
Of unit then convert it to the required unit by raising the conversion coefficient to the same power
Of unit
(3)if units consist of more than one measuring unit:
Convert the numerator and denomiator to the required unit by previous steps

*example:
(1)A car moves a distance of 5km,so this distance is equivalent to……
(a)$5x10^{-5}$cm (b)$5x10^{-2}$ cm (c)$5x10^{2}$cm (d)$5x10^{5}$cm
soluation
s=$5x10^{3}$ m
=$5x10^{3}x10^{2}$cm
=$5x10^{5}$cm

---

(2)there is an electric current of intensity 7 milliampere (7mA),then this ntensity in microampere (μA)is……….

(a)$7x10^{3}$ (b)$7x10^{6}$ (c)$7x10^{9}$ (d)$7x10^{12}$
Solution
I=7mA=$7x10^{-3}$A
=$7x10^{-3}x10^{6}$μA
=$7x10^{3}$ μA

---

(3)a car moving on a highway at a velocity of 37.5 m/s.if the maximum speed allowed on this road is 120km/h,had the driver exceeded this velocity?
(a)yes, the velocity of the car is larger than the allowed velocity by 10km/h
(b) yes, the velocity of the car is larger than the allowed velocity by15k/h
(c) no, the velocity of the car is smaller than the allowed velocity by10km/h
(d) no, the velocity of the car is smaller than the allowed velocity by15km/h
Solution
V=37.5m/s=$37.5\frac{m}{s}$=$37.5\frac{10}{\frac{1}{60}x\frac{1}{60}}\frac{km}{h} = 135\frac{km}{h}$

The driver exceeds the allowed velocity by (Δv):

Δv=135-120=15km/h

The measuring unit of velocity km/h can be converted to m/s as follows :

Dimentional formula

The general dimentional formula of any physical quantity is:

$$[A]=M^{\pm a}L^{\pm b}T^{\pm c}$$

How to deduce the dimensional formula of the velocity (v) as an example:

	Steps	examples
1	Write down the mathematical lation that determine the physical quantity	potential energy P.E.=(m.g.h)
2	Write down the relation in terms of the fundamental (physical quantities) M,L and T	[P.E.]= $M.\frac{L}{t2}.L$
3	Put on each of the symbols M,L and T it's suitable power and arrange them in the order of) M .L .T(If one or more quantities is not present in the formula it can be	

expressed as M^0 ‘T^0 Such as $x^0 = 1$ so it's not written. The measuring unit can be obtained from the dimensional formula.	$M.L^2.T^{-2}$ And it's unit $= Kg.m^2 sec^{-2}$

Quantity	Rule	D.F	Unit
length		L	m
mass		M	kg
time		T	s
Area(A)	Length× length	$L \times L = L^2$	M^2
Volume(V)	Length × length × length	$L \times L \times L = L^3$	m^3
Density(ρ)	$\frac{mass}{Volume}$	$M/L^3 = ML^{-3}$	$Kg.m^{-3}$
Velocity(v)	$\frac{Displacement}{Time}$	LT^{-1}	$m.s^{-1}$
Accleration(a)	$\frac{Change\ of\ velocity}{Time}$	LT^{-2}	$m.s^{-2}$
Force(F)	mass×accelration	MLT	$Kg.m.S^{-2}$
Work(W)	force ×displacement	ML^2T^{-2}	$Kg.m^2.s^{-2}$
Momentum(P_L)	mass×velocity	MLT^{-1}	$Kg.m.s^{-1}$

Note: we can multiply or divide physical quantities of different dimensional formula but it can't be added or subtracted because D.f is $\mathrm{M}.\mathbf{L}.\mathbf{T}$ only without writing anynumerical constants as shown:

- $\mathrm{M}^*\mathrm{L}\mathbf{T}^{-2} = \mathrm{ML}\mathbf{T}^{-2}$
- $\mathrm{ML}\mathbf{T}^{-2} \div \mathrm{M} = \mathrm{L}\mathbf{T}^{-2}$
- $\mathrm{L}\mathbf{T}^{-2} + \mathrm{L}\mathbf{T}^{-2} = \mathrm{L}\mathbf{T}^{-2} \neq 2\ \mathrm{L}\mathbf{T}^{-2}$
- $\mathrm{L}\mathbf{T}^{-2}$ - $\mathrm{L}\mathbf{T}^{-2} \neq 0 = \mathrm{L}\mathbf{T}^{-2}$

Note: numerical constant such as (2 , $\frac{1}{2}$, π) and trigonometric functions such as (sin θ , cos θ, tan θ) have no dimensions.

*the importance of dimenstional formula:

Verify the validity of a physical relation

*If X=Y this relation may be correct if the dimensional formula of (X)=if the dimensional formula of(Y)

Example(1)a body of masss m moves with velocity v and it's kinetic energy is KE,so which of the following relations may be correct?

(knowing that:(KE)=ML^2T^{-2})

(a)KE=$1/2m^2v$ (b)KE=2mv (c)KE=$1/2mv^2$ (d)KE=$2m^2v^2$

(soluation)

**The dimensions of the L.H.S(KE)=ML^2T^{-2}

so the dimensions of the R.H.s must equal ML^2T^{-2}

(2) If measuring unit of a physical is $\mathrm{Kg}/\mathbf{m}^2.\mathbf{s}^2$

Then the dimensional formula is …………

a)$\mathrm{M}\mathbf{L}^2\mathbf{T}^{-2}$ b) $\mathrm{M}\mathbf{L}^2\mathbf{T}^2$ c) $\mathrm{M}\mathbf{L}^{-2}\mathbf{T}^{-2}$ d) $\mathrm{M}\mathbf{L}\mathbf{T}$

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(3) **:** If (x= yz) where the dimensions of

(x)= ML^2T^{-3} and the dimensions of (y)= LT^{-2} then the dimensions of (z) are ……

a) MLT^{-1} b) MLT C) LT^{-1} d) MLT^{-5}

Work sheet

Choose the correct answer :

1)the fundamental physical quantities of the following are ……………….

a)length and area b)the velocity and the acceleration
c)the mass and volume d)the time and the mass

2)a common feature in the french system (gaussian) , the britich system and the metric system is that they all measure ………………………………….

a)length b)mass c)time d)temperature

3)femtosecond =…………………… microsecond

a) 10^{-15} **b)** 10^{-9} **c)** 10^{9} **d)** 10^{6}

4)if x=10g and y=10 kg ,then the value of (x+y) is …………………………………….

a)10.1 kg b)100.1 g c)10.01 kg d)10.01 g

5)how many bottles of volume 10000 cm^3 **is enough to fill a tank of capacity 1** m^3

a)1 b) 10 c)1000 d)100

6)if the measuring unit of acceleration is m/s^2 **and its dimensional formula is** $Lx.T-y$

a)x=1 , y=1 b)x=1 , y=2 c)x=1 , y= -2 d)x=-1 ,y = 2

7)if the dimension formula of the quantity A are$M.L2.T-2$ **and the dimensions of the quantity B are** $M.L2.T-2$ **, then the quantity of (2B-A) ……………………………..**

a)has dimensional formula $M.L2.T^{-2}$
b)has dimensional formula $M2.L4.T^{-4}$
c)has dimensional formula $M3.L6.T^{-6}$
d)isn't a physical quantity

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8)th measuring unit of the physical quantity that has a dimensional formula of $M.L.T^{-1}$ is ....
(knowing that , the newton (N)is equivalent to $Kg.m/s^2$, the joule (J)is equivalent to$Kg.m^2/s^2$

a)$N.m$ **b)**$J.m^{-1}$ **c)**$N.s$
d)$J.s^{-1}$

9)if the force (F) with which the liquid resists the motion of a ball of radius r that moves at velocity v is given by the relation F=krv , then the dimensional formula of the quantity k is ....
a)$M.L.T$ **b)**$M^{-1}.L.T$ **c)**$M^{-1}.L^{-1}.T$ **d)**$M.L^{-1}.T^{-1}$

10)a body of initial velocity vistarts motion with uniform acceleration
(a) to cover a displacement(d) within time (t) to reach final velocity v_f after this time
***which of the following equations are correct ??**

a)$v_f=v_i+at^2$ **b)**$v_f^2=v_i^2+2ad$
c)$v_i=v_f+2adt$ **d)**$v_f=v_i+at$

Essay questions :

1)is the physical quantity that ia measured by $kg.m^{-3}$fundamental or derived quantity ? and why ?
....
....
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....
2)deduce the dimensional formula of each of the following .
1) Force(F) 2) Work (W) 3) presure (P)
(P= F/A)

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3)why is not the glass used in manufacturing of the standard meter ?

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Lesson(2)types of measurement&measurement error

Measurement process cannot be accurately 100% but there should be even a simple percentage of error.

Reasons for measurement errors:

No.	Reason	Example	Figure
1	Choosing unsuitable tool	Using a normal balance instead of sensitive balance to measure mass of a golden ring.	
2	A defect in the measuring tool	Old ammeter, Due to weak magnet and pointer of ammeter does not start from zero graduation.	
3	Wrong procedure	The vision must be perpendicular to the cylinder.	19.82 ml 19.70 ml 19.62 ml 19 20
4	Environmental factors (temperature, humidity and air currents)	Using sensitive balance in presence air currents.	

*note :to reduce the error precentage in the measurement we calculate the average as follows:

Average of reading = $\frac{sum\ of\ reading}{the\ number\ of\ taking\ reading\ for\ the\ measured\ quantity}$

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Types of measurement

Direct measurement	indirect measurement
One measuring tool is used	More than one measuring tool is used
No mathematical relation is applied	A mathematical relation is applied to find the quantity
One measurement error may occur	More thanOne measurement error may occur
Like measure the density by using the hydrometer	Like measure the density by measure mass and volume
HYDROMETER READ AT BOTTOM OF MENISCUS READING: 22.5	measuring cylinder 20cm³ water 50.0 70.0 electronic balance

1- Calculation of error in direct measurement

Absolute error (Δx)	Relative error (r)
The difference between actual value for measuring quantity (x_o) and measured value (x) $\Delta x = \lvert x_o - x \rvert$	The ratio between absolute error (Δx) to real value for measuring quantity (x_o) $r = \frac{\Delta x}{x_o}$
This sign of modulus (| |) indicates the results are (+ve) even if the real value less than measuring quantity.	**The relative error** indicates accuracy of measurement as long as relative error **decreases** the measurement is more **accurate**.

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Has measuring unit Which is the same as the unit of the physicalquantity.	**Has no measuring unit** Because it's the ratio between two quantitieshaving the same measuringunit.

- ***The result of measurement is expressed as (x_o ± Δx).***

Absolute error	**relative error**
$\Delta x = \lvert x_o - x \rvert$	$r = \frac{\Delta x}{x_o}$

example:

Example 1 : student measures length of pencil = 9.9 cm and real length of it = 10cm while another student measures length of room = 9.13m while real length of it = 9.11m .

a) Calculate the absolute error and the relative error in each case.

b) In which case was the measurement more accurate andwhy.

***Solution*:**

In case the first student

- the absolute error

In case the second student

- the absolute error

$\Delta x = |x_o - x| = |10 - 9.9|$

$= 0.1$ cm

- the relative error

$r = \frac{\Delta x}{x_o} = \frac{0.1}{10} = 0.01 = 1\%$

The length of pencil

$= (10 \pm 0.1)$ cm

$\Delta x = |x_o - x| = |9.11 - 9.13|$

$= 0.02$ m $= 2$ cm

- the relative error

$r = \frac{\Delta x}{x_o} = \frac{0.02}{9.11} = 0.0022 = 0.22\%$

The length of room

$= (9.11 \pm 0.02)$ m

b) The measurement in the second case is more accurate **because** the relative error in second case is less than that in the first case.

2- Calculation of error in indirect measurement

Mathematical relation	Example	How do you calculate the error?
Addition	Measure volume of two amount of liquid $V_T = V_1 + V_2$	Absolute error (Δx) = absolute error in the first measurement + absolute error in the second measurement $\Delta x = \Delta x_1 + \Delta x_2$ The relative error (r) $= \frac{\Delta x}{x_o}$
Subtraction	Measure volume of coin = (volume water +coin)(V_2) – volume of water(V_1) $V_{coin} = V_2 - V_1$	
Multiplication	Measure area of rectangle by measuring the length and the width then multiple (length × width).	The total relative error (r) = the relative error in the first measurement + therelative error in the second measurement $r_T = r_1 + r_2$ the absolute error $\Delta x = r_T \, . \, x_o$
Division	Measure density of liquid $D = \frac{M}{V} = \frac{mass}{volume}$	

Example: In an experiment for determination of physical quantity (L) that is formed from , L_2 Where L_1 = (5.2 ± 0.1) cm and L_2 = (5.8 ± 0.2) cm. Calculate value (L) and the relative error.

Solution:

The real value (L_o) = 5.2 + 5.8 = 11 cm

Absolute error (ΔL)= 0.1+0.2 = 0.3 cmL

= $L_o \pm \Delta L$ = (11 ± 0.3) cm

Relative error(r)=$\frac{\Delta L}{L_o}$=$\frac{0.3}{11}$== .027

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Work sheet

Choose the correct answer :

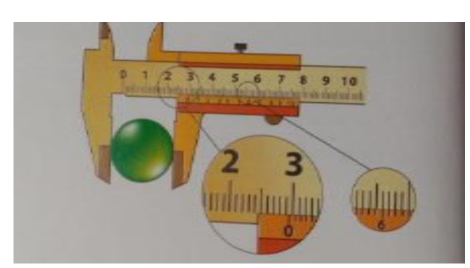
1)the best way to judge the accuracy of measurement is though ....

a)absolute error
b) dividing of the relative and absolute error
c)the product of the relative and absolute error
d) relative error

2)the relative error in measuring the area of a room is 0.06 where the actual value of the area is 30m^2 , then the absolute error in measuring this area is..................

a)1.8m^2 b)0.002m^2 c)0.06 m^2 d)1.2 m^2

3)the vernier caliper was used to measure the diameter of a metallic



ball as shown , then :
***the measured value =........................**

a)2.54 cm b)2.45 cm c)2.46 cm d)2.64 cm

***if the real value of the diameter of the ball is 2.53 cm , so the percentage of error and absolute error are ……………………**

a)4.3% , 0.11 cm **b)0.4% , 0,01 cm**
c)2.8% , 0,11 cm **d)3.2% , 0.01 cm**

4)the percentage of the error in meaduring the side length of a cube is 1 % , then the relative error in measuring its volume is …………………

a)0.01 **b)0.02** **c)0.03** **d)0.04**

11) when the velocity of an object measured by equation $v{=}\Delta d\Delta t$ **and the relative error for each d and t is 0.2 ,0.1 and absolute error of velocity =1.5m/s . the real value of velocity ……..**

a)0.45 **b)0.2** **c)15** **d)5**

essay questions:

1)the absolute error is the best indicator for masurement accuracy . discuss the validity of the previous sentence .

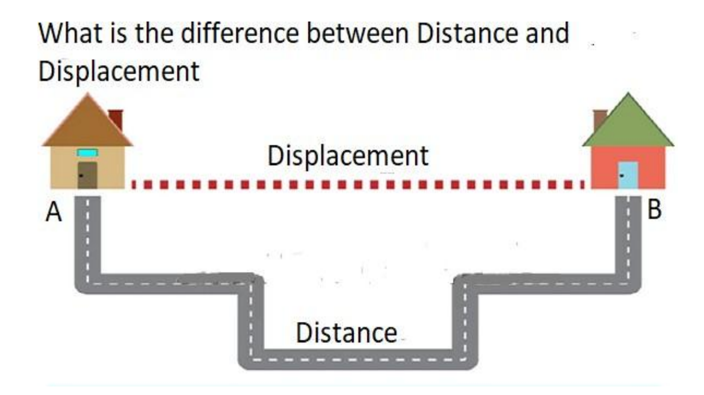
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2)there are 4 different physical quantities and their results were
a) $(10{\pm}0.1\ )$ **b)** $(1{\pm}0.01\ )m$ **c)** $(50{\pm}0.5\ )kg$ **d)** $(200{\pm}0.02\ )s$
arrange these measurements in ascending order according to their accuracy .

…………………………………………………………………………
…………………………………………………………………………
…………………………………………………………………………

Chapter(2)Scalar Quantity Vector Quantity

Scalar quantity	Vector quantity
It is a physical quantity that can be fully defined by its magnitude only, it has no direction.	It is a physical quantity that can be fully defined by both magnitude and direction.
Examples☺ 1 - Distance. 2 - Speed. 3 - Time. 4 - Mass. 5 - Energy. 6 - Temperature.	Examples☺ 1 - Distance. 2 - Speed. 3 - Time. 4 - Mass. 5 - Energy. 6 - Temperature.
Distance(s)	Displacement(d)
The length of the path from start point to end point Scalar quantity Always positive	The length of straight line from start point to end point and the direction (shorter distance) Vector quantity It may be positive ,negatgive or zero



*The magnitude of the displacement is less than or equal the covered distance
*If the body moves from position $x_i$to position x_f the displacement calculated from the relation $d=x_f-x_i$

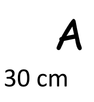
In one constant direction	From a to b , then the magnitude of displacement = the distance	
In 2 opposite directions	*doesn’t return to its starting point : distance = ab +bc Displacement = ab-bc (Note)*return to the starting point : Distance =2ab Displacement =0	

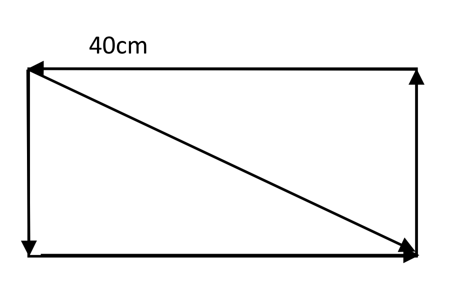
If body moves in 2 dimensions:-

In straight path	Distance =AB+BC Displacement=AC Distance =AB+BC+CD Displacement=AD Distance = AB+BC+CD+DA Displacement=0	
In curved path	Distance $=12\pi r$ Quate revolution Displacement $=\sqrt{2}r$ Distance = πr Displacement=$2r$ Distance = $2\pi r$ Displacement=0	**Quarter revolution** **Half revolution** **Complete revolution**

Example :

In the rectangle in the fig Calculate the distance and displacement in





b

$\overline{AB}$, $\overline{AC}$, $\overline{AD}$, along perimeter of rectangle

Solution:

$\overline{AB}$: Distance= 30 m, displacement=30m

$\overline{AC}$: Distance = 30 + 40 = 70m

Displacement = $\sqrt{30^2 + 40^2}$ = 50 m

$\overline{AD}$: Distance = 30 + 40 + 30= 100 m

Displacement =40 m

Along perimeter of rectangle:

Distance = 30 + 40 + 30 40 = 140 m

Displacement = zero

Representation of vector quantities

the vector quantity is represented by a directed straight segment(→)whose base is at the starting point and its tip is at the end point :

*its length is proportional to the vector **magnitude**

*the arrow direction points to the **direction** of the vector quantity

*the vector quantity is denoted by a bold letter(A)or a letter tagged by a small arrow which always refers to the right side ($\underset{A}{\rightarrow}$)

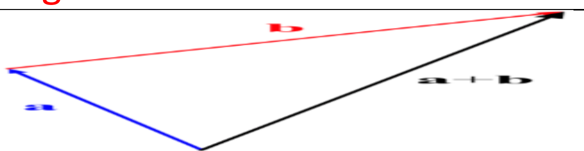
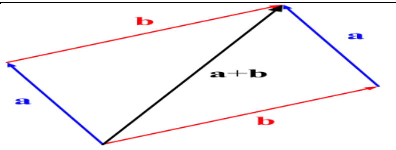
***some basics of vector algebra:-**

1)two vectors are equal if($\vec{A}=B$)	2) two vectors are not equal if($\vec{A} \neq B$)	3)negative vectors	4)the product of a constant magnitude by a vector
*have same magnitude *have same direction *different or same starting point	Have different directions (even if they have thesamemagnitude) *differenet magnitudes (even if they have the same direction)	have the same magnitude of possitve vector but has the opposite direction	vector ($2\vec{A}$) is double the magnitude of vector ($\vec{A}$) and ($-2\vec{A}$)is double the magnitude of vector ($\vec{A}$) but has the opposite direction

Vector algebra

1) addation and subtraction:

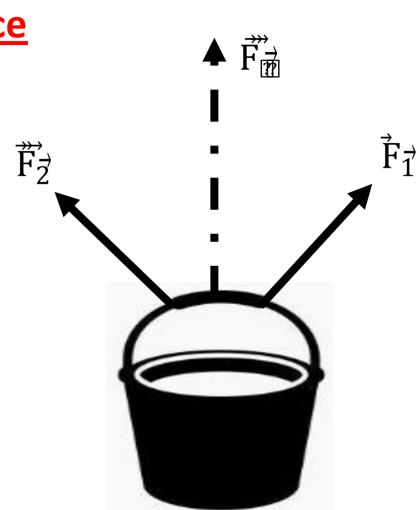
We have two methods :-

1)triangle method	2rectangle method
	
If the end of the first vector is the start of thesecond one.	If they have the same startpoint
Draw a triangle as shown in Figure and the resultant vector representative by the vector starting from start point of first vector to the end point of the second vector	Draw a parallelogram where A and B are two adjacent sides and the resultant vector representative by the diameter as shown in Figure have the same start point

---

Resultant force

When two forces or more act on an object(as shown in fig)it will move in a certain direction determined by the resultant of the forces acts on the object which is called **Resultant force($\vec{F}_R$)**



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The **Resultant force** $(\vec{F}_{\vec{R}})$ is a single force that produce the same effect on an object as that produced by the original acting forces.

Resolution of the vector

To determine the net (Resultant) force of two perpendicular forces:

*To measure the value of an **angle** (θ) by the relations:

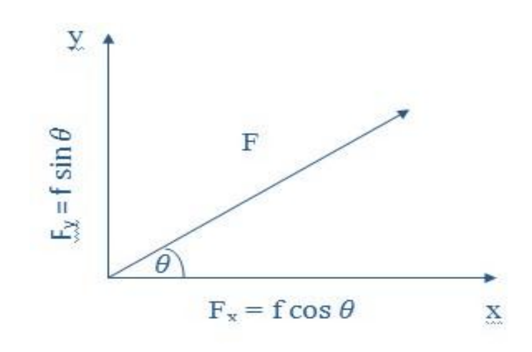
$$\text{Sin } \theta = \frac{Opposite}{Hypotenuse} = \frac{\overline{CB}}{\overline{CA}}$$

$$\text{Cos } \theta = \frac{Adjacent}{Hypotenuse} = \frac{\overline{AB}}{\overline{AC}}$$

$$\text{Tan } \theta = \frac{Opposite}{adjacent} = \frac{\overline{CB}}{\overline{AB}}$$

Analysis of the vector:

The force can be resolved into :



$$F_x = F \cos(\theta)$$

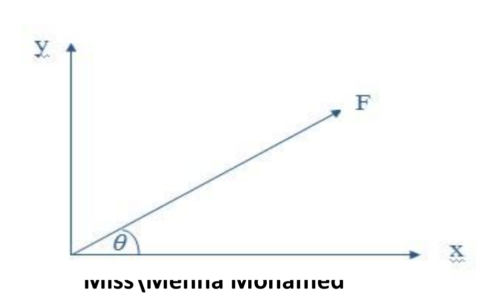
$$F_y = F \sin(\theta)$$

Example: a boy pulls a stone with a force (20N) by a string makes angle (30°) with the ground. Calculate the force's value in x-direction and y-direction.

Solution:

$F_x = F\cos(\theta)$ = 20 cos30 = 17.3 N

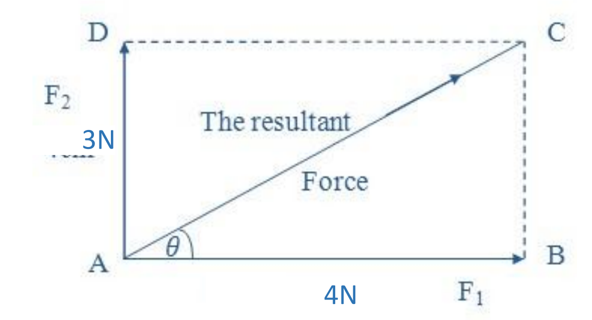
$F_y = F \sin(\theta)$= 20 sin30 = 10N



Example 4: If a force of (4N) acts on an object on x-axis direction and another force (3N) acts on the same object in Y-axis direction. Find the **resultant force** on this body.

Solution:

$$F^2 = F_x{}^2 + F_y{}^2$$

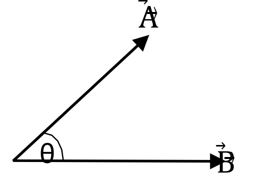


$$F = \sqrt{F_x{}^2 + F_x{}^2} = \sqrt{3^2 + 4^2}$$

F = 5 N .... ***(Magnitude)***

$$\text{Tan } \theta = \frac{Opposite}{adjacent}$$

θ = 36.87° ....(direction)



2)Multiplication of vectors (There are two types):

1)Scalar product (Dot Product):

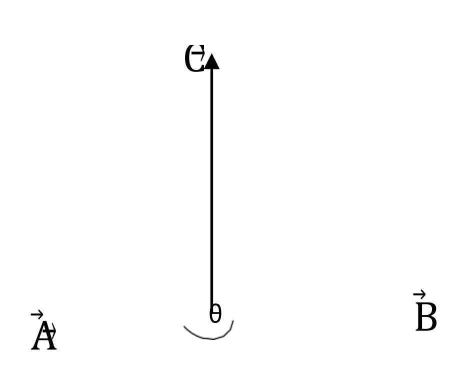
$\vec{A} \cdot \vec{B} = |A||B| \cos(\theta)$ (scalar quantity)

If **θ=90°** Then **($\vec{A} \cdot \vec{B}$) =** $|A||B|$ **cos(90)=** **zero**

If **θ=0°** Then **(($\vec{A} \cdot \vec{B}$) =** $|A||B|$ **cos(0)= (maximum value)**

2)Vector product (cross Product):

When multiplying to vectors $\vec{A}$ and $\vec{B}$ the result will be another vector $\vec{C}$ which is perpendicular to the plan of both vectors $\vec{A}$ and $\vec{B}$.

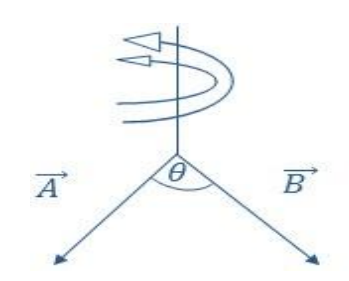


The vector (cross)product of two vectors $\vec{A}$ and $\vec{B}$ is expressed as:

$\vec{C} = \vec{A} \wedge \vec{B} = |A|\,|B| \sin(\theta)\, \vec{n}$

Right hand rule

$\vec{n}$: is the **unit vector perpendicular to** the plane of $\vec{A}$ and $\vec{B}$.



$$\vec{A} \wedge \vec{B} = |A|\,|B| \sin(\theta)\, \vec{n}$$

(Vector quantity)

If $\theta=90^o$ Then $\vec{A} \wedge \vec{B} = |A|\,|B| \sin(90)\, \vec{n}$ **=(maximum value)**

If $\theta=0^o$ Then $\vec{A}\ \vec{B} = |A|\,|B| \sin(0)\, \vec{n}$ = **zero**

Notes: right hand rule is to determine the direction of $\vec{C}$

If $\vec{A} \wedge \vec{B}$ ($\vec{A}$ to $\vec{B}$) the vector $\vec{C}$ will be upward and vice versa

$\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A}$	$\lvert \vec{A} \cdot \vec{B} \rvert = \lvert \vec{A} \wedge \vec{B} \rvert$ if $\theta=45^0$
$\vec{A} \wedge \vec{B} \neq \vec{B} \wedge \vec{A}$	$\vec{A} \wedge \vec{B} = - \vec{B} \wedge \vec{A}$
$\vec{A} \wedge \vec{B} = 0$ if $\theta=0^0$ ($\vec{A} \parallel \vec{B}$)	$\vec{A} \cdot \vec{B} = 0$ if $\theta=90^0$ ($\vec{A} \perp \vec{B}$)

work shEET

*Choose the correct answer:-

1)a rubber ball fell from 50 cm high and kept boncing along a vertical path to reach 30 cm then 10 cm *the total distance covered by the ball is ………………

a)180 cm b)130 cm c)129 cm d)90 cm

2)two forces act on the same body , one of them $F1$ is in the direction of north and its magnitude is 9 N and the other $F2$ in the direction of west and its magnitude is 12 N , then the magnitude of the resultant of the two forces F
equals ……………….

a)225 N b)12√2N c)15 N d)√15 N

3) in right hand rule , the thumb refers to …………..

a)first vector b)second c)scalar product d)vector product

4)an athlete covers a displacement of 250 m ti east then returned 100 m to the west the distance covered by him equal ……..

a)350 m b)250 m c)150 m d)100 m

and the displacement of this athlete …………..

a)350 m to east b)350 m to west c)150 m to east d)150 m to west

6)an object has moved from position A to position B covers 6 m then it changes its direction to reach to position C covers 5 m

A B C

*the covered distance equal ……………

*the displacement of the object equals ………………..

a)14 m in AC direction b)14 m in CA direction

c)10 m in AC direction d)10 m in CA direction

7)an object moves along the circumference of a circle of radius r . the ratio between the distance covered by it and the magnitude of its displacement during ½ of a revolution is …………………

a)π b) 2π c)$\pi/2$ d)$\pi/4$

---

8)vector $\vec{A}$ has magnitude 5 units and vector $\vec{B}$ has magnitude 4 units , then the magnitude of the resultant of the 2 vectors $\vec{A}$ and $\vec{B}$ can not be equal to ………units

---

a)1 b)6.4 c)9 d)12

Unit (2):linear motion

Lesson (1): Motion and velocity

Objects around us can be sorted into stationary objects and moving objects. As we study the motion of different objects, it is necessary to describe and understand such motion. The vague ideas about motion convert travelling by ships, trains andplanes into a mess. Schedules of departure and arrival ofdifferent transportations are mainly based on distances, timesand speeds. So, in this chapter we are going to investigate theconcept of motion and the related physical quantities

1)Motion :the change in position of an object relative to another static object as time passes .

***Types of motion:-**

Translational motion	Periodic motion
The motion which has starting point Andend point	The motion that repeats itself in .equal interval of time
.Motion in straight line	.Motion in circle

2)Velocity

the rate of change of displacement.

Or: the displacement of an object in one second.

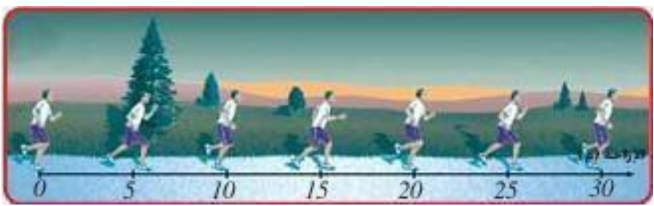
. It ismeasured in (m/s) or (km/h).

$$\text{Velocity} = \frac{\textbf{the change of displacement}}{\textbf{Time of change}} = \frac{\Delta d}{\Delta t} = v = \frac{d_2 - d_1}{t_2 - t_1}$$

Example 1: Using the following motion diagram for athlete

displacements every one second. Calculate the velocity of him.

<u>Solution:</u> We can describe the motion of athlete using the following table



Time(s)	0	1	2	3	4	5	6
Displacement(m)	0	5	10	15	20	25	30

$$\text{Velocity} = \frac{\textbf{the change of displacement}}{\textbf{Time of change}}$$

Types of velocity:

(A) Speed and Velocity:

Focusing on the speedometer of a car, its pointer swings right and left during car movement. The pointer reading specifies the value of the car speed (for example, 80 km/h) without defining the direction of the car motion. This value is known as (Speed).



However, just saying that a car moves at 80 km/h is an incomplete description since no hint is given about the direction of the car motion. Accordingly we need to define such direction to give a full description for the car motion. For instance, saying that the car moves at 80 km/h to east. In this case, we call this (Velocity).

Point of comparison	Speed	Velocity
Definition	The distance moved by an object by unit time	The displacement of an object by unit time
The Type	Scalar quantity	Vector quantity
The Sign	Always positive $v = \frac{change\ ofistance}{change\ of\ time}$	Can be positive or negative depend on the direction of motion

Note: (**speed = velocity**)at straight line motion in one direction.

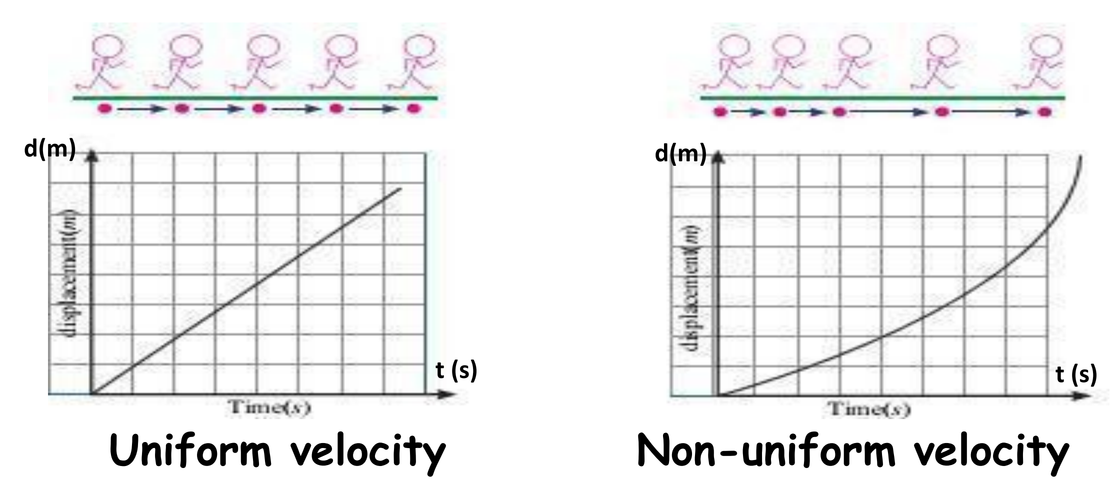
B) Uniform and non-uniform Velocity:

As an athlete runs at uniform velocity, his **displacements are equal** in **equal times**. But if he moves at non uniform velocity, his **displacements are unequal in equal times**.

1- **Uniform velocity:** An athlete velocity when it is displaced through **equal displacements in equal times**. Both the velocity magnitude and direction are constant (when the object moves in a straight line).

2- **Non-uniform velocity:** An athlete velocity when it is displaced through **unequal displacements in equal times**. Its velocity may change in magnitude or direction.

And it represents graphically as following:

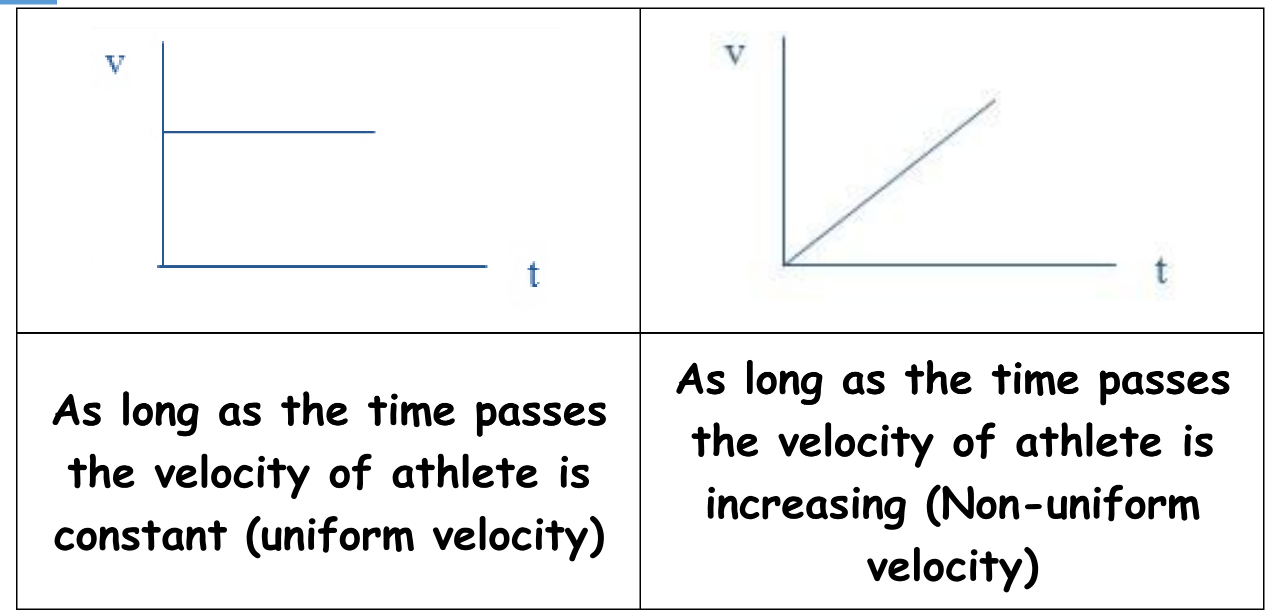


Uniform velocity   Non-uniform velocity

Uniform velocity: Represents as **a straight line** due to the equal displacement in equal intervals of time.

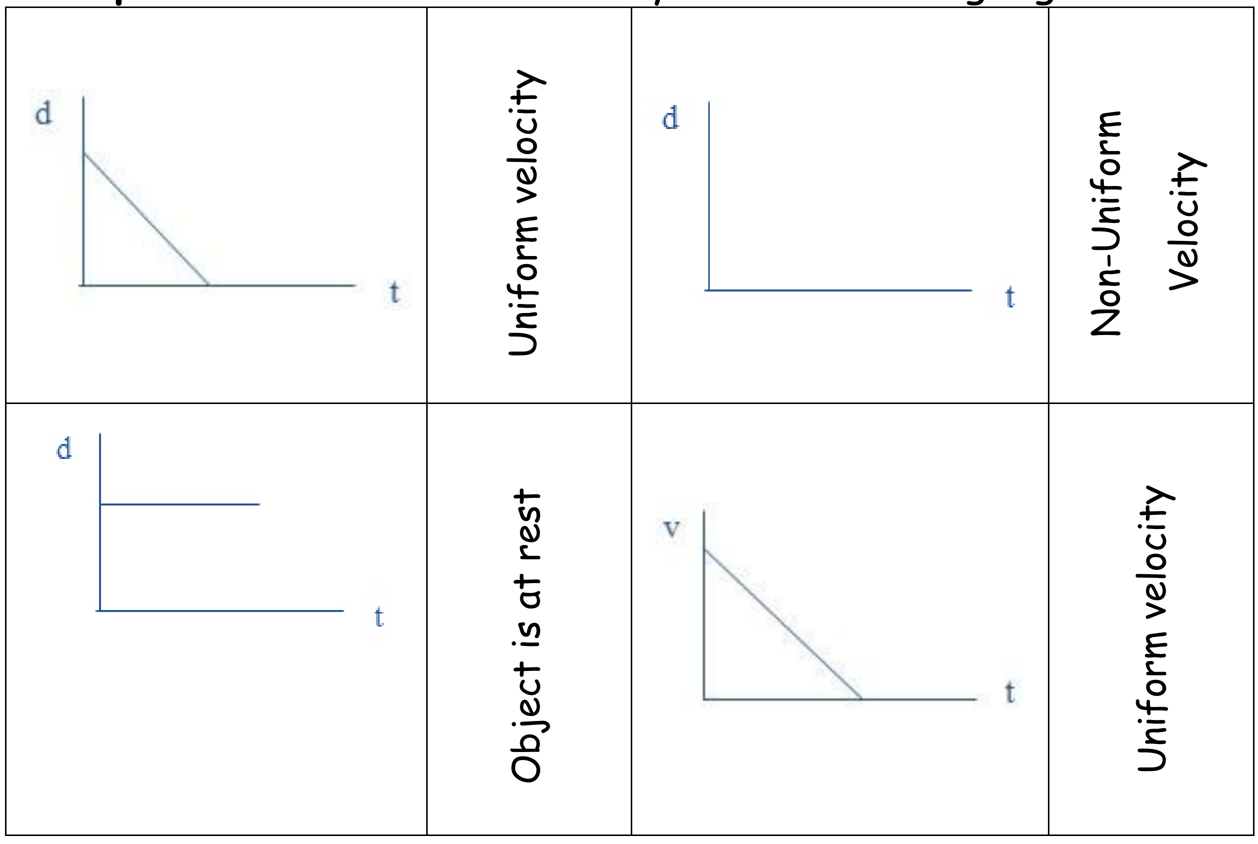
Non-Uniform velocity: Represents as **a curve** due to the unequal displacement in equal intervals of time.

When plotting the relation between velocity and time wemay get:



v, t (graph)	v, t (graph)
As long as the time passes the velocity of athlete is constant (uniform velocity)	As long as the time passes the velocity of athlete is increasing (Non-uniform velocity)

Example 2: describe the velocity in the following figures



d, t (graph)	Uniform velocity	d, t (graph)	Non-Uniform Velocity
d, t (graph)	Object is at rest	v, t (graph)	Uniform velocity

C) Instantaneous velocity (v) and average velocity ($\bar{v}$)

instantaneous velocity (v)	average velocity ($\bar{v}$)
The velocity of the object at certain instant	The average of the body's velocity during a certain interval of time
d Instanteaus velocity t	d d t t
$\bar{v} = \frac{\text{Change in displacement}}{\text{change in time}}$	$\bar{v} = \frac{\text{total displacement}}{\text{total time}}$
$v = \frac{\Delta d}{\Delta t}$	$\bar{v} = \frac{d_1+d_2+d_3}{t_1+t_2+t_3}$

Note: The average velocity differs from the average speed

where: **average speed =** $\frac{\text{total ditance}}{\text{total time}}$ (scalar quantity).

But **average velocity =** $\frac{\text{total displacement}}{\text{total time}}$

Work sheet

Choose the correct answer :

1)if a car is moving in a straight line to cover a distance of 300 m in a minute , the car's average speed ....

a)300m/s b)260 m/s c)240 m/s d)5 m/s

2)if a car covered 30 km in the south direction during 0.5 h , then it covered 40 km in the east direction during 2.5 h ,so .
***the magnitude of the average velocity ....**

a) 8.24 km/h b)12.54 km/h c)16.67 km/h d)18.22 km/h
***the average speed of the car ....**
a)16.67 km/h b)23.33 km/h c)25.21 km/h d)27.42km/h

3)in a football match , the ball was 50 m away from a player who was running towards it at uniform velocity of 3 m/s , meanwhile another player was at 35 m from the ball and ran at uniform velocity of 2 m/s toward the ball , so the first player reaches the ball ....

a)before the second player by a time of 0.83 s
b)before the second player by atime of 0.55 s
c)after the second player by a time of 0.83 s
d)after the second player by atime of 0.55 s

4)the position of a body is given by the relation $x=10\ t^2$, where x is measured In seconds , so the average velocity through the interval from t=2s to t=3s equals.........................

a)50 m/s b)30 m/s c)26 m/s d)10m/s

5)a body moves along a staight line at velicity v to cover a distace d , then it moves in the same direction at velocity 2v to cover a distance 4d , so its total average velocity equals ....
a) v b) 32v c) 2v d) 53 v

6)a car is moving in a straight road for time t by an average velocity v , then it moves for time 2 t by an average velocity 2 v , so its total velocity ....

a) v b) 32v c) 2v d) 53 v

7)if a car is moving in a straight road in one direction to cover one third of the distance at velocity of 25 km/h and the rest of the distance was covered at velocity of 75 km/h , so the average velocity of the car ,............................

a)30 km/h b)45 km/h c)50 km/h d)65 km/h

8)a body moves in a straight line for one minute with a velocity 10 m/s then it moves for another minute with a velocity of 20 m/s , so the average velocity of the body equals ……………..

a)15 m/s b)13 m/s c)7.5 m/s d)5 m/s

9)a body moves in a straight line with a velocity of 10 m/s for a distance of 100 m then it moves a distance of 100m with a velocity 20 m/s so the average velocity ……………..

a)6.66 m/s b)10 m/s c)12.5 m/s d)13.33 m/s

10) a girl is running in a straight line with a constant velocity of 5 m/s from point A to point B , then she returns back in a straight line from point A to point B with a constant velocity 3 m/s so ,

***the average speed during the whole journey equals ……………….**

a)3.75 m/s b)1.875 m/s c)0.533 m/s d)0

***the magnitude of the average velocity during the whole journey equals……………..**

a)3.75 m/s b)0.26 m/s c)0.13 m/s d)0

11)the opposite graph describes the motion of two boys

d (m)
A
B
x
t (s)

A and B that are moving in a uniform velocity in a straight line .
which of the following sentences is right ?

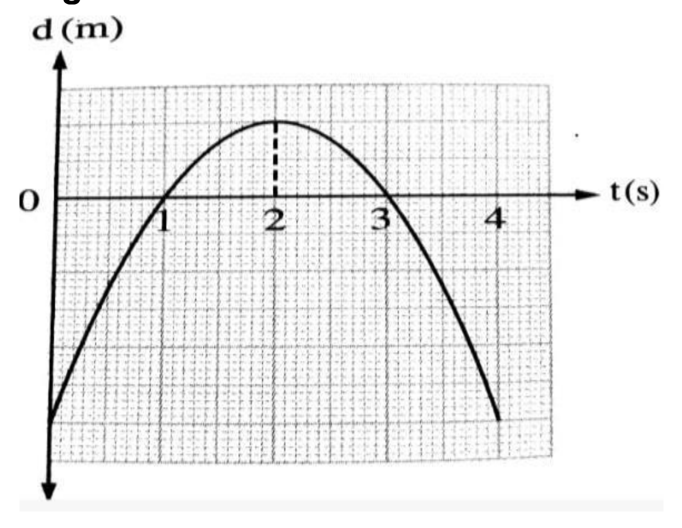
a)B stats his motion after A
b)the velocities of A and B are equal
c)the velocities of A and B are equal at point x
d) A precedes B after passing point x

essay questions :

1)compare between average velocity and average speed

………
………
………
………
……………………………………………

2)the opposite (displacement – time)graph describes the motion of a body in the straight line .
Is the velocity of the body positive or negative or zero at :



a)t = 1s b)t =2s c)t =3s

Lesson(2)

Acceleration

3-Acceleration:

We have discussed the concept of the variable velocity (magnitude, direction or both). Motion in which velocity changes with time is called the accelerated motion and the quantity that expresses the change of velocity per unit time is called acceleration (a). To investigate the concept of acceleration, study the following motion diagram that illustrates the readings of the speedometer of a car moving from rest and speeds up in a straight line.



Acceleration:

The change of the object velocity per unit time, or the rate of change of velocity. It is measured in (m/S^2) or (km/h^2).

$$a = \frac{\Delta v}{\Delta t} = \frac{final\ velocity - initial\ velocity}{Final\ time - initial\ time} = \frac{\Delta x}{\Delta t^2}$$

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Note: You can convert the speedometer reading from km/h into m/s by the relation:

1km/h = $\frac{1000\ m}{60*60\ sec} = \frac{5}{18}$ m/s

Example: Recording the data of an object moves with velocity (m/s) and time (s), we obtained by the table below:

Time (S)	0	1	2	3	4
Velocity (m/s)	0	5	10	15	20

It is obvious that the car speeds up at a constant rate where its velocity increases by (5m/s) every second. This value expresses the acceleration of motion that can be found by the relation:

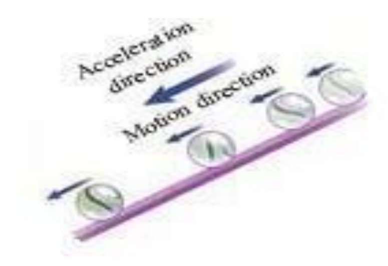
$$a = \frac{change\ of\ the\ velocity}{change\ of\ time} = \frac{final\ velocity - initial\ velocity}{Final\ time - initial\ time} = \frac{20}{4} = 5 m/s$$

Types of acceleration:

Objects may move at positive acceleration (increasing velocity), negative acceleration or deceleration (decreasing velocity) or zero acceleration (uniform velocity). These types can be identified by studying the following motion diagram that shows the motion of a small ball along frictionless planes of different inclination





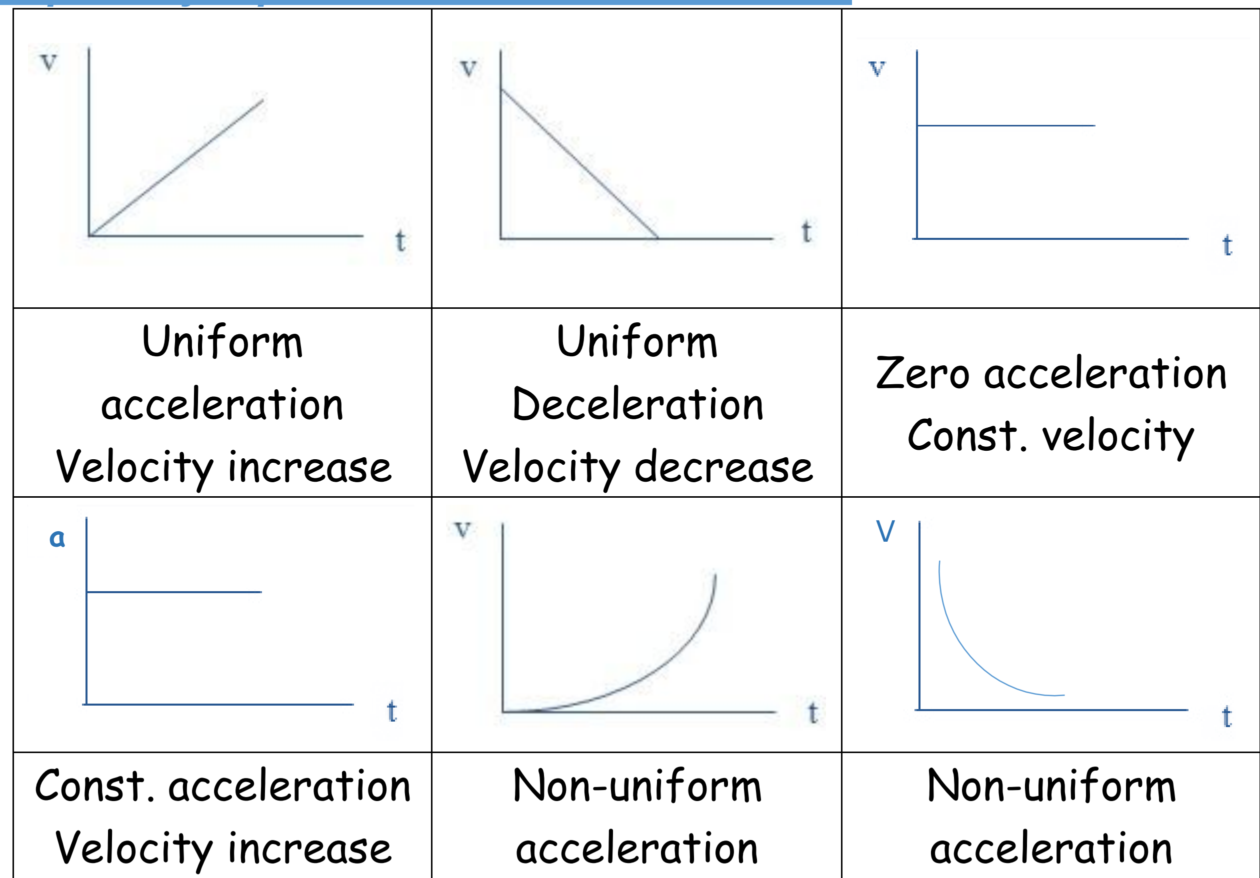


As the ball climbs up the inclined plane, its velocity decreases with time and acceleration is negative

As the ball moves along the smooth horizontal plane, its velocity does not change with time and acceleration equals zero

As the ball rolls down the inclined plane, its velocity increases with time and acceleration is positive

Graphically representation for acceleration:



Types of acceleration:

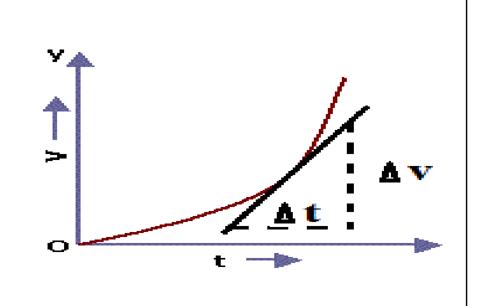
1. **Uniform acceleration**: It means that the rate of change invelocity is constant

2. **Non uniform acceleration**: It means that the rate change invelocity is variable

- When $v_f > v_i$ so it's a positive acceleration (+ ve)
- When $v_i > v_f$ so it's a negative acceleration (- ve)

It means also: The object moves with unequal amounts of velocity (velocity changes) with equal intervals of time.

Slope = $\frac{\Delta v}{\Delta t}$ = acceleration (a)



Work sheet

Choose the correct answer :

1) if a body starts its motion from rest and moves by acceleration a to reach a velocity vf
After time t , so its final velocity vf can be represented by the relation ....

a)$vf=at$ **b)** $vf=at$ **c)** $vf=12\ at^2$ **d)** $vf=\sqrt{a}t$

2)if an object starts its motion from rest and speeds up at a constant rate till its velocity becomes 50 m/s during 10 s , this object moves at an acceleration of ....

a)$15\ m/s^2$ **b)** $5\ m/s^2$ **c)** $40\ m/s^2$ **d)** $60\ m/s^2$

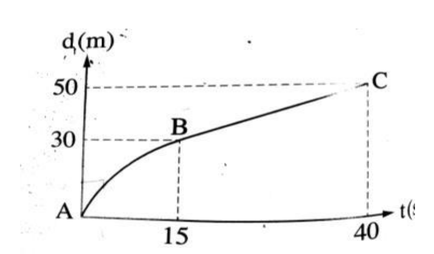
3)a man starts its motion from rest with uniform acceleration 0f $1\ m/s^2$, then his average velocity equals 1 m/s during .... from starting his motion

a)1 s b)2 s c)4 s d)1/2 s

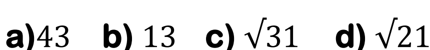
4)in positive acceleration ....
a)initial velocity > final velocity **b)initial velocity >final velocity**
c) initial velocity = final velocity **d)velocity has variable direction**

5)the opposite graph represents (d) and the time (t) for a body moves in a straight line , then the acceleration by which the body moves during the intervals AB and BC are ....

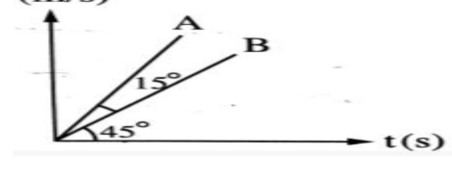
	AB	BC
a	Negative	Positive
b	Negative	zero
c	Positive	Positive
d	Positive	zero



6)the opposite graph shows the relation between velocity (v) and time (t) of two bodies A and B that start their motion from rest , so the ratio between the acceleration of body A and body B is ....

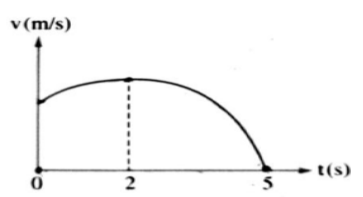



a)43 **b)** 13 **c)** $\sqrt{31}$ **d)** $\sqrt{21}$



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7)the opposite (velocity – time) graph represents the motion of a car in a straight road , so which of the following sentences is correct ?
a)the car is static at t = 0
b)the car returns to its starting point during 5 s



c)the dispalcement of the car increases from t = 0 to t = 5 s
d)the acceleration of the car is maximum at t = 2 s

8)which of the following senteces is correct ....

a)if the velocity of the body at a certain moment equals zero , the acceleration of the body at this moment must equal zero .

b)if the acceleration of the body equal zero , its velocity must be equal zero .

c) if the velocity of the body at a certain moment equals zero , the acceleration of the body at this moment may not equal zero .

d)the direction of the acceleration of a body is always in the direction of its velocity .

9)which case of the following cases is impossible to happen?..............................

a)a body is moving with velocity to the east and its acceleration is in the west direction
b) a body is moving with velocity to the east and its acceleration is in the east direction
c) a body is moving with variable velocity and costant acceleration
d) a body is moving with costant velocity and variable acceleration

essay questions

1)if a body starts its motion from rest and moves with uniform acceleration , where its average velocity during 2 sec from starting its motion is 3 m/s . calculate its average velocity during 5 sec from starting its motion

....
....
....
....

2)a train moves with a uniform velocity of 40 m/s . it takes 6 seconds to pass a standing man , calculate the length of the train .

Chapter Two — Motion with uniform acc.

In the previous chapter you have studied that the acceleration is the change in velocity per unit time. This acceleration may be uniform (constant) or varying or zero.

$$a = \frac{\Delta v}{\Delta t} = \frac{\Delta x}{\Delta t^2}$$

Motion of an object at uniform acceleration has a special importance since it represents the motion of a number of objects in our experience. Examples may include those objects falling near the Earth's surface and projectiles.



Figure (13): falling of water from the top of a waterfall is at uniform acceleration



Figure (14): skating in air is at uniform acceleration

Assuming that an object moved in a straight line at **uniform acceleration (a),** and started motion from **rest** at **initial velocity (v_i)** It reached a **final velocity (v_f)** after **an interval**

(t) during which it was displaced through **a displacement (d)**,We can describe such motion using three certain equations called equations of motion as follows:

lesson (1)Equations of motion:-

1^{st} equation of motion:

(velocity – time)

$a = \frac{\Delta V}{t}$

$a = \frac{Vf - Vi}{t}$

At=Vf – Vi

$V_f = v_i + at$

2^{nd} equation of motion

(Displacement – time)

$V_{av} = \frac{d}{t}$

$\because V_{va} = \frac{Vf + Vi}{2}$

$\frac{Vf + Vi}{2} = \frac{d}{t}$

2d = (Vf + Vi) t

From 1st eq. (Vf = Vi + at)

2d = (Vi + at + Vi)t

2d = (2Vi + at) t

$D = v_i t + \frac{1}{2} a t^2$

3^{rd} eqyation of motion

(Displacement – velocity)

$V_{av} = \frac{d}{t}$

$d = V_{av} .t$

$\because V_{av} = \frac{Vf + Vi}{2}$

From 1st eq. $t = \frac{Vf - Vi}{a}$

$d = \frac{Vf + Vi}{2} \times \frac{Vf - Vi}{a}$

2ad = (Vf + Vi) (Vf – Vi)

$2ad = V_f^2 - v_i^2$

$V_f^2 = v_i^2 + 2ad$

The graphical representation of equations of motion (v_i=0)

The 1[st] equation	The 2[nd] equation	The 3[rd] equation
$v_f = a\,t$	$d = (\frac{1}{2}\,a\,t^2)$	$2ad = v_f^{\,2}$
v, t	d, t^2	V^2, d
The slope = $\frac{v}{t}$ = a	The slope = $\frac{d}{t^2} = \frac{1}{2}$ a	The slope = $\frac{v^2}{t}$ = 2a

If (v_i≠0) the graphical representation will be:

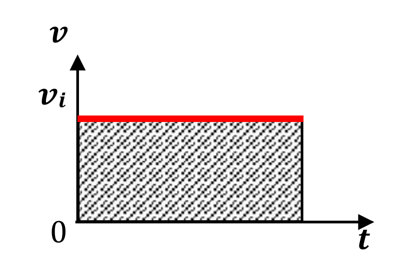
The 1[st] equation	The 2[nd] equation	The 3[rd] equation
$v_f = v_i + a\,t$	$d = (v_i\,t + \frac{1}{2}\,a\,t^2)$	$2ad = v_f^{\,2} - v_i^{\,2}$
v, v_f, v_i, 0, t	d, 0, t^2	v^2, $v_f^{\,2}$, $v_i^{\,2}$, 0, d
The slope = $\frac{\Delta v}{\Delta t}$ = a	The slope = $\frac{\Delta d}{\Delta t^2} = \frac{1}{2}$ a	The slope = $\frac{\Delta v^2}{\Delta d}$ = 2a

Deriving the second equation of motion graphically

In case of motion at **Uniform velocity** which is represented by straight line parallel to the time axis. Displacement= velocity $*$ time

Displacement= area under the graph

d = $v_i * t$ (1)



In case of motion at uniform acceleration we can divided the area below the curve into

- Area of rectangle = $v_i * t$
- Area of triangle $= \frac{1}{2} * Base * hight$

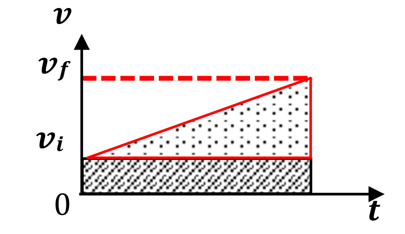
$= \frac{1}{2} * t * (v_f - v_i)$

But $(v_f - v_i)$ = a t

So area of triangle = $\frac{1}{2}$ a t^2 (2)

By adding (1) + (2) we will find

$$d = (v_i t + \frac{1}{2} a t^2)$$



Some important special cases:

The general formula	a body start from rest (v_i = 0)	a body stops (v_f = 0)	moves with uniform velocity (a =0)
$v_f = v_i$ + a t	v_f = a t	$-v_i$ = a t	$v_f = v_i$
$d = (v_i t + \frac{1}{2} a t^2)$	$d = (\frac{1}{2} a t^2)$	$d = (v_i t + \frac{1}{2} a t^2)$	$d = v_i t$
$2ad = v_f^2 - v_i^2$	$2ad = v_f^2$	$2ad = - v_i^2$	$v_f = v_i$

Guidelines may help to solve the problems:

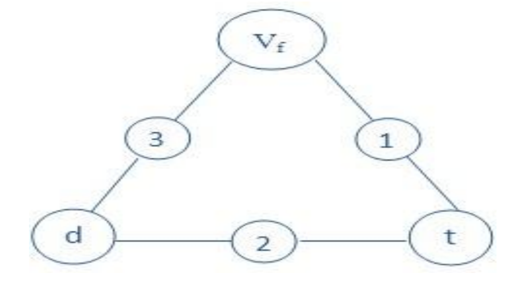
1) If the object moves at a uniform velocity, it's **acceleration= zero** Because(the change in velocity Δv =0)
2) When the object starts the motion from the rest, itsinitial velocity v_i = zero.
3) If the driver applies the break till the car stops its final velocity v_f = zero.
4) If the object moves in a straight line with uniform acceleration, it's average velocity is given from relation

$$\bar{v} \text{ (Average velocity)} = \frac{v_f + v_i}{2} .$$

5) If ($v_f > v_i$) speed increases it means: acceleration is **positive** (if velocity is positive).
6) If ($v_i > v_f$) speed decreases it means: acceleration is **negative** (if velocity is positive).
7) If the velocity and acceleration have **the same direction**then they have **the same sign (accelerating motion)** if both where in (+ve) direction or in (–ve) direction.
8) If the velocity and acceleration have **the opposite direction** then they have the **opposite sign** (**decelerating**).
9) When? Means find the time (t).
10) Where? Means find the displacement (d).

Key of problem:

This triangle is used to solve equations of motion where the number indicates number of equation to solve the problem.



Work sheet

Choose the correct answer :

1)what is the time required for a plane to completely stop when landing on a straight runway of an air port , if you know that its velocity was 50 m/s when touching the surface of the run way and it decelerates uniformly by a rate of 2 m/s^2 ?...

a)5 s b)10 s c)12.5 s d)25 s

2)a radar monitors the motion of the car that moves on a straight road with uniform acceleration of -4 m/s^2 , it finds that the velocity of the car was 13 m/s at 10:05:00 am , then its velcoity at

***10:04:59 am equals ....**

a)17 m/s b)9m/s c)7m/s d)5m/s

***10:05:01 am equals ....**

a) 17 m/s b)9m/s c)7m/s d)5m/s

3)a train moves at a straight line with an acceleration of 2 m/s^2 that has an opposite direction to its motion . then the time required to change its velocity from 72 km/h to 13 km/h equals ....

a)6.2 s b)8.2 s c)11.8 s d)29.5 s

4)if an object starts its motion from rest in astraight line with uniform acceleration and takes time (t) which is numerically equal to the magnitude of its acceleration (a) to reach a final velocity of 16 m/s , so the magnitude of the acceleration ....

a)2 m/s^2 b)4 m/s^2 c)8 m/s^2 d)16 m/s^2

5)a body starts its motion from rest and moves with constant acceleration in astraight line . if the average velocity during 8 sec is 1.5 m/s , so its instantaneous velocity is ……………….after 30 sec from starting its motion

a)15.4 m/s b)12.5 m/s c)11.25 m/s d)9.25 m/s

6)if the displacement of a body that moves with uniform acceleration is given by the relation $d=v_it+12at^2$ **and the body starts its motion with acceleration a= 2** m/s^2 **when its initial velocity** $v_i=10m/s$ **, then its displacement after 10 sec is ……………….**

a)100 m b)200 m c)300 m d)400 m

7)a body move in straight line with uniform velocity of 4 m/s for 8 sec , then it movesin the same direction with a uniform acceleration of 4 m/s^2 **for 6 sec , so the total distance covered by the body equals ………….**

a)128 m b)80 m c)68 m d)56 m

8)two bodies start their motion from rest and move in astraight line with uniform accleration to cover a distance (d) . if the time taken by the first body to cover this distance is double the time taken by the second body , then the ratio between the acceleration of the first body and the acceleration of the second body is ……………………………

a) 12 **b)** 11 **c)** 14 **d)** 116

9)a train of length 100 m enters a straight tunnel of length 1 km with a velocity of 4 m/s . if the train is moving by acceleration of 0.5 m/s^2 **, then the required time for the entire train to leave the tunnel is ……………………….**

a)550 s b)58.81 s c)20.31 s d)20 s

10)a tiger started running when it saw a deer runing at uniform velocity of 2m/s at 15 m far from it . if the tiger ran at acceleration of 2 m/s^2 , then the tiger catch the deer after :
***passing a time of ………………… from starting the motion**

a)5 s b)4 s c)2.5 s d)1 s

***covering a distance of …………………**

a)25 m b)15 m c)10 m d)5 m

11)a motorcyclist started motion from rest in a straight line at a uniform acceleration of 1.5 m/s^2 . so its velocity has reached 7.5 m/s through a displacement of ……………………………….
a)11.25 m b)18.75 m c)187.5 m d)1875 m

12)the final velocity of a body moving with uniform acceleration is given by the relation : $v_f=\sqrt{v_i{}^2+2ad}$. if the initial velocity of the body is 6 m/s and it moves by an acceleration of 4 m/s^2 , then its velocity is …………………… after covering a displacement of 8m

a)5 m/s b)10 m/s c)15 m/s d)20 m/s

13)a car is moving with velocity of 56 km/h and the minimum distance that would be taken by the car to stop is 12 m . if the car moves with velociity of 113 km/h , then the minimum distance would be taken by the car to stop is …………………………
(Assuming that the acceleration is constant in both cases)
a)97.7 m b)49.2 m c)48.9 m d)24.4 m

14)car accelerates uniformaly from rest to reach velocity (v) when it covers distance (d) , so the velocity of the car when it covers distance (2d) from starting its motion is ……………………

a) v **b) $\sqrt{2}$ v** **c) 2 v** **d) 4 v**

15)a body starts its motion from rest and moves with uniform acceleration , if its average velocity is 10 m/s when it covers a displacement of 20 m , then its average velocity during 8 sec from starting its motion is ………………………………

a) 2 m/s **b)40 m/s** **c) 10 m/s** **d)80 m/s**

essay questions :

1)a body starts its motion from rest and moves in straight line with acceleration of 2 m/s^2 to cover a distance of 100 m , then it moves with acceleration of 4 m/s^2 to cover a distance of 200 m . calculate the average velocity of the body .

……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
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…………………………………

Lesson 2

Applications of motion with uniform acceleration

(Free fall – Vertical projectiles)

1) Free fall:

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If we drop a book and a sheet of paper at the same instant from the same height, which of them reach the ground first? But, when the sheet of paper is placed adjacent to the book topside and allowed to fall, what would you observe? Explain your observation.

When an object falls to ground, its motion is affected by two forces:

1) Gravitation pull of earth (their weight).

2) The air resistance due to collisions between the object and air molecules.

The impact of this resistance is greater on the velocity of falling of light objects than that of heavier objects. Note that no air resistance affected the sheet of paper when it was placed adjacent to the topside of the book during falling.

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Conclusion: To simplify this issue, we are going to study the fall of objects under the effect of their weights, only neglecting the effect of air resistance. This motion is called free fall. It is worthy to mention that **at the absence of air resistance**, **all objects fall to the ground at the same acceleration**.

Notes:

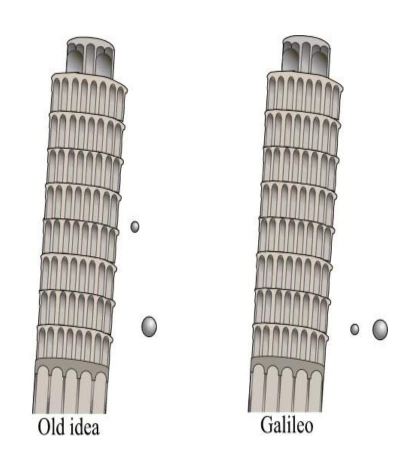
1) if the objects fall under the effect of their weights only and acquire a uniform acceleration that acts to **increase the speed of falling** gradually till it reach its **maximum value** when touching the ground .this acceleration called **free fallacceleration** which is **uniform** acceleration.

2) The free fall acceleration varies slightly from one position to another on the Earth's surface **because** the Earth's surface is not completely spherical but it's elliptical, where its equatorial diameter is bigger than its polar diameter, so the free fall acceleration varies depending on the distance from the Earth's center.

3) The average value of free fall acceleration equals (9.8 m/s^2) for the simplicity it can be considered (10 m/s^2)

Distinguished scientists:

Galileo proved that **falling objects of different masses reach the ground at the same time, when air resistance is neglected**.
By dropping two objects of different masses down Tower of Pisa. This experiment put an end for Aristotle thoughts that implied that heavier objects would reach the ground first.



Free fall acceleration (g):

It is the uniform acceleration of objects that fall freely. This acceleration equals (9.8 m/s^2) and means that the **object's velocity** when falling freely increases by **(9.8 m/s)** every **second**.

When an object falls under the effect of gravity we can apply the motion equations:

$$v_f = v_i + g\,t \qquad d = (v_i\,t + \frac{1}{2}\,g\,t^2) \qquad 2gd = v_f^2 - v_i^2$$

1) When an object falls freely (from up to down):

v_i = zero

v_f = max. before touching theground

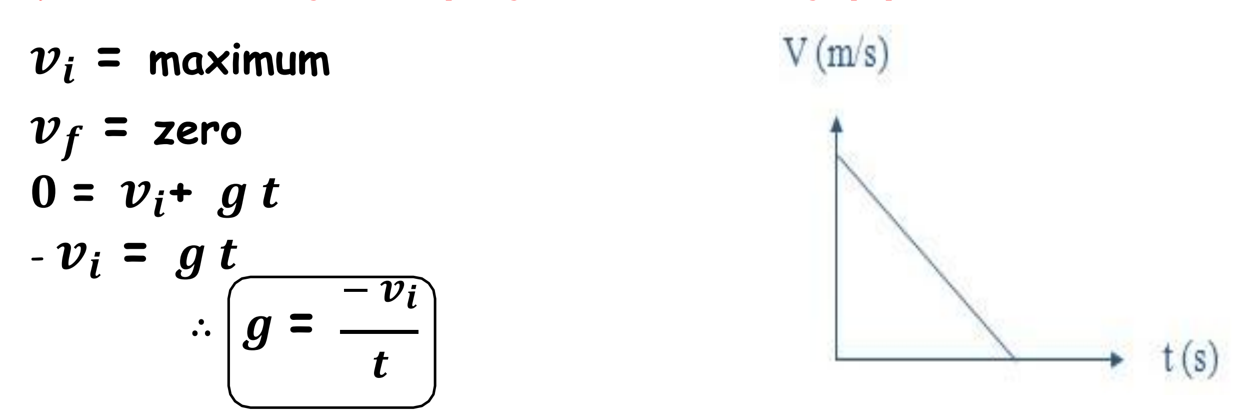
$v_f = 0 + g\,t$

$$\therefore \boxed{g = \frac{v_f}{t}}$$

V (m/s)

t (s)

2) When an object is projected vertically (upwards):



v_i = maximum

v_f = zero

$0 = v_i + g\,t$

$-v_i = g\,t$

$$\therefore \boxed{g = \frac{-v_i}{t}}$$

g:is (–ve) because the body moves against the earth's gravity

Example 1:

A stone fell from the roof of a building. If the stone passed by a man standing in a balcony 5 m high above the ground (2 seconds later) (consider g = 10 m/s^2)

a) The building height
b) The stone velocity at the moment of passing by a man.

Solution: $v_i = 0$ g = 10 m/s t = 2s d_2 = 5m

a) The height of the building (h) = the distance from roof tobalcony (d_2) + the distance from balcony to ground (d_1)

$$d_2 = (v_i t + \frac{1}{2} g t^2) = 0 + (\ ) \frac{1}{2} * (10) * (2)^2 = 20 \text{ m}$$

The height of the building (h) = $d_1 + d_2$ = 20 + 5 = 25 m

b) The stone velocity when it passes in front of the man

$$v_f = v_i + g\,t \quad = \quad 0 + (10) * (2) = 20 \text{ m/s}$$

Example 2:

An apple has fallen freely from a tree and reached the ground after 1 sec. Find: (g = 10 m/s^2)

a) Its velocity at the moment of hitting the ground.
b) The average velocity of the apple during falling.
c) The height from which it fell

Solution: $v_i = 0$ g = 10 m/s t = 1s

a) Velocity at reaching the ground v_f

$$v_f = v_i + g\,t \quad = 0 + (10) * (1) = 10 \text{ m/s}$$

b) (Average velocity) $\bar{v}$= $\frac{v_f + v_i}{2} = \frac{10 + 0}{2}$ = 5 m/s

c) The height from which the apple fell

$$d = (v_i t + \frac{1}{2} g t^2) = 0 + \frac{1}{2} * (10) * (1)^2 = 5 \text{ m}$$

Projectiles: there's two types of projectiles

a) Vertical projectiles b) Two- dimensional projectiles

a) Vertical projectiles:

a) When an object is projected vertically upwards, it starts at initial velocity (v_i) which doesn't equal zero and moves with uniform acceleration (-ve) ≈ -10 m/s^2.

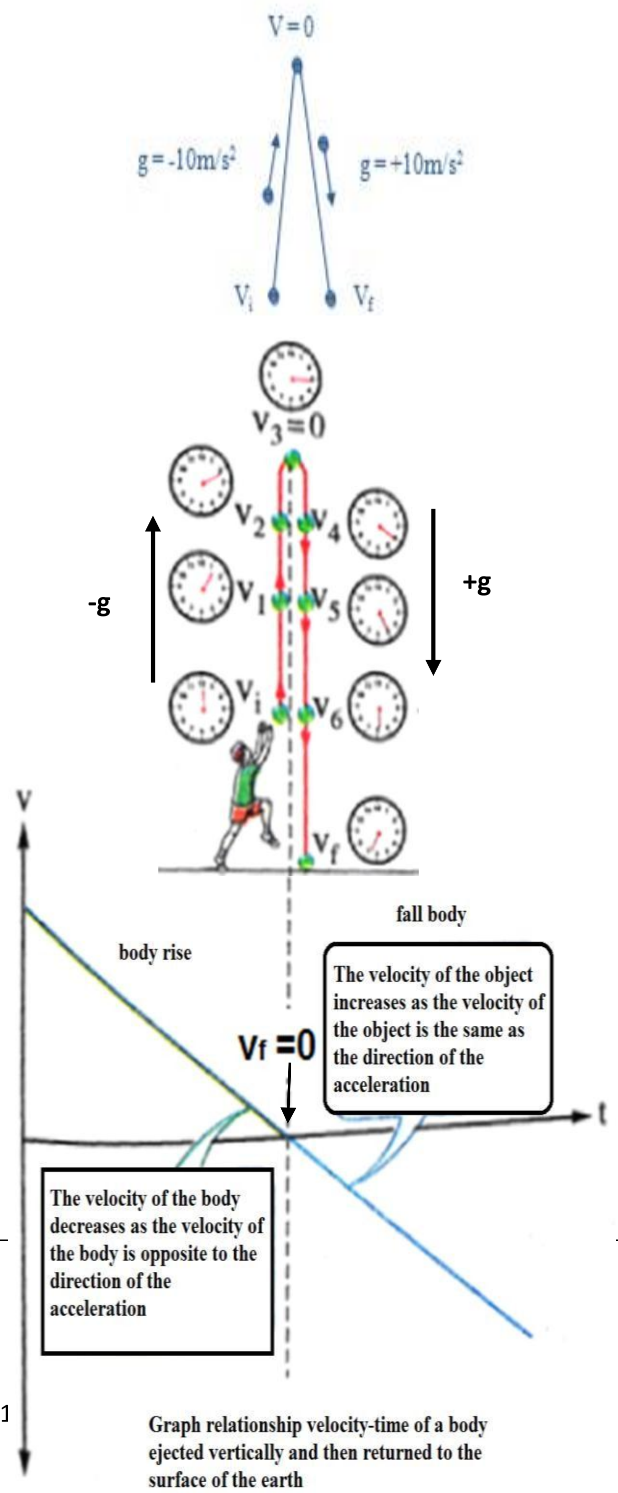
b) The velocity of the object **decreases** gradually as the object gets higher and reaches **zero** at the **maximumheight**.

c) The direction of velocity changes when the object returns back to the ground under the effect of Earth's gravity that makes the object accelerate (+ve) ≈ (10m/s^2).

d) The velocity of the object when it's projected up = (-ve) its velocity at the same height when it falling down.

E) The time of rising to the maximum height = the time of falling to the same level of projection.

F) The total flight time = The time of rising + the time of falling.



Graph relationship velocity-time of a body ejected vertically and then returned to the surface of the earth

Example 3: An object projected vertically upwards at initial velocity 98 m/s find: (g = 9.8 m/s²)

a) The maximum height reached by the object.

b) The time taken to reach that height

Solution: v_i = 98 v_f = 0 g = - 9.8 m/s t_1 = ?? d_1= ??

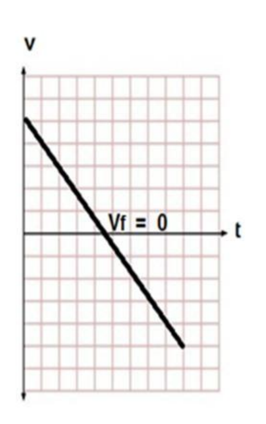
a) $2gd = {v_f}^2 - {v_i}^2$

$2 * (-9.8) * d = 0 - (98)^2$ d= $\frac{-(98)}{2*(-9.8)}$ = 490 m

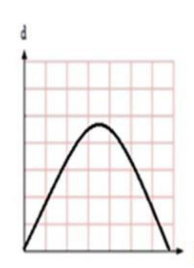
b) $\boldsymbol{v_f = v_i + g\,t}$

0 = 98 - 9.8 (t) So 89 = 9.8 (t) t = 10 sec

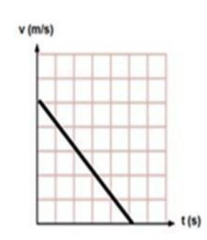
Note: Important graph relationships



An object was ejected vertically and then returned to the surface of the earth



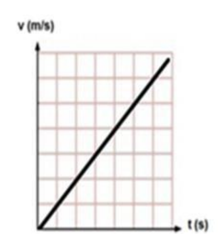
An object was ejected vertically and then returned to the surface of the earth



vertically projected body upwards

slope = -g

$V_f = V_i + gt$



A body in a free fall

slope = g

$V_f = V_i + gt$

0

Work sheet

Choose the correct answer :

1) a ball is projected vertically upwards to reach the maximum height (h) after 3 s , then the value of (h) is …………………………..

a) 20 m b)45 m c)55 m d)60 m

2) two bodies of different materials having the same volume fall freely together from the same height , neglecting the air resistance which of the following statements is correct ?

a)the heavier body reaches the ground first .
b)the lighter body reaches the ground first .
c) the heavier body accelerates more .
d)they reach the ground at the same time .

3)an object falls freely . given that (g=10 m/s^2), its velocity 3 seconds later becomes …………………

a)29.4 m/s b)98 m/s c)19.6 m/s d)9.8 m/s

4)two bodies of masses 5 kg and 25 kg fall freely at the same moment from a point 10 m high above the ground , then the time taken by each body to reach the ground is ………………….. respectively

a)1.43 s , 1.43 s b)1.43 s , 0.48 s c)1.01 s , 1.01 s d)1.01 s , 0.34 s

5)an object falls freely from 3.2 m high above the moon's surface . if it takes 2 s to reach the surface , then the acceleration due to mon's gravity equals ………………………..
(assume that the body moves under the effect of the moon's gravity)

a)3.2 m/s^2 b)1.6 m/s^2 c)0.8 m/s^2 d) 0.4 m/s^2

6)a stone falls from the edge of a wall that contains water at 122.5 m from the edge of the well . how many soconds will pass to hear the sound of the stone hitting the water ??
(sound velocity = 343 m/s , g=10m/s2)

a)4.64 s b)5 s c)5.36 s d)5.72 s

7)a man drops astone from the top of building and when the stone covers 10 m the man drops another stone , if the height of the tower is 100 m , then the time difference between the dropping of the two stones is ………………….

a) 1/2 s b) √2 s c) 2 s d) 2√2 s

8)if a body falls freely where its velocity after covering a distance of 1m from the start of its motion is v m/s , then its velocity after 1 s from the start of its motion is ………………………. m/a

a) v^2 b) $2v$ c) $v^2/2$ d) $\sqrt{2}\, v$

9)an object falls from the top of a building of height (2 d) , then it reaches the middle of the building after time (t) , so it covers the other half of the building during time ………………….(g=10m/s2)

a) $\sqrt{2}\, t$ b)0.5 t c) 0.33 t d) 0.41 t

10)two solid balls of the same volume are projected vertically upwards from the same level with the same initial velocity , where one of them is metallic and the other is wooden . if the denisty of the metal is larger than the density of the wood , then ………………….

a)the two balls reaches the level of projection at the same instant
b)the metallic ball reaches the level of projection first
c)the wooden ball reaches the level of projection first
d) we can't determined the answer

11)the maximum height for a jamp recorded by a player in the basketball game was 1.25 m , so the flight's time of this player in the air is ……………….

a)0.05 s b)0.25 s c)0.5 s d)1 s

12)a body is projected vertically upwards to reach maximum height of 80 m , then :…………………..

***the velocity of the projection is ……………………..**

a)39.6 m/s b)28 m/s c)19.8 m/s d)14 m/s

***the time taken by the body to return to the point of projection is ………………………………**

a)2.85 s b)4.04 s c)5.71 s d)8.08 s

13)a body was projected vertically upward with initial velocity 98 m/s , then : (g=10m/s2)

***the velocity of the body after 5 seconds from the moment of projection …………………….**

a)147 m/s b)93 m/s c)49 m/s d)24.5 m/s

***the maximum height reached by the body ………………………..**

a)980 m b)490 m c)414 m d)397 m

***the total time taken by the body from moent of projection till it returns to the point of projection is …………………………………….**

a)10 s b)18.9 s c)19.7 s d)20 s

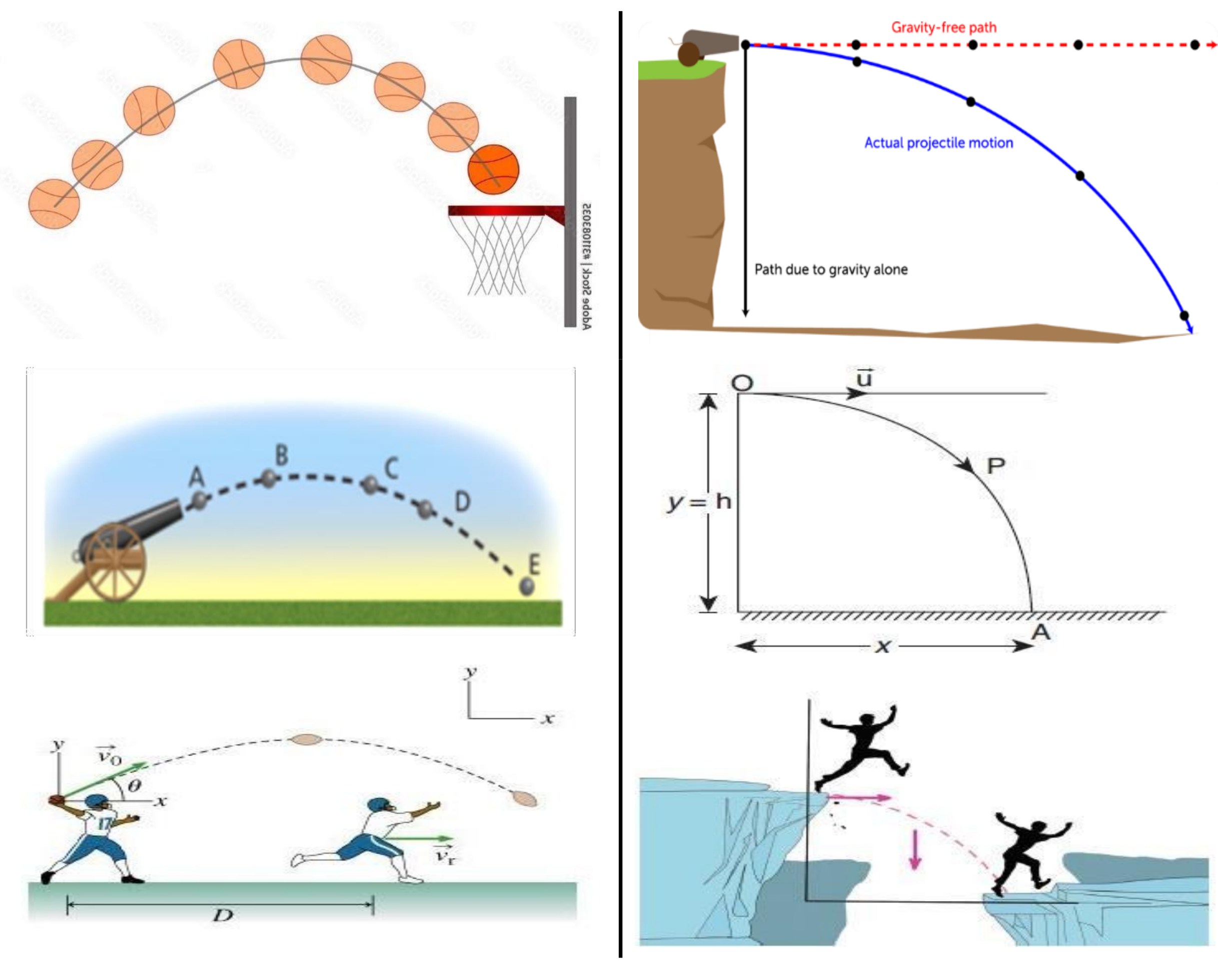
14)an object is projected vertically upwards with initial velocity of 60 m/s , then : ($g=10m/s2$)
***the time taken by the object to reach avelocity of 20 m/s is ……………………..**
a)8 s b)4 s c)2 s d)0.25 s
***the height of the object when it reaches a velocity of 20 m/s is ……………………………..**
a)320 m b) 200 m c)160 m d)80 m

15)a stone is thrown vertically downwards at velocity of 96 m/s into a well to reach the bottom after 3 s , then the depth of the well is …………………………($g=10m/s2$)
a)376.2 m b) 332.1 m c)243.2 m d)199.8 m

b) (lesson3)Projectiles when projected at an angle (Motion in two dimensions):

We have studied the motion of objects at uniform acceleration in a straight line either in a horizontal, inclined or a vertical plane. At the moment, we are going to study objects motion when projected at an angle to the horizontal under the effect of gravity.

A projectile such as a ball or a cannonball is launched with an initial velocity v_i at an angle θ with the horizontal, it moves in a curved line like shown in the figures.



We can resolve velocity in Two dimensions Horizontal (x) And vertical (y) as shown in the figur

The velocity of a body is always in the direction of motion tangential to the trajectory

at maximum height

$0 = v_{2y}$

v_{1y} v_{1x} v_{0y} v_{0x} v_{3x} v_{3y}

v_{0x} v_{1x} v_{2x} v_{3x}

Horizontally the body moves at a constant speed
Because the horizontal acceleration = zero

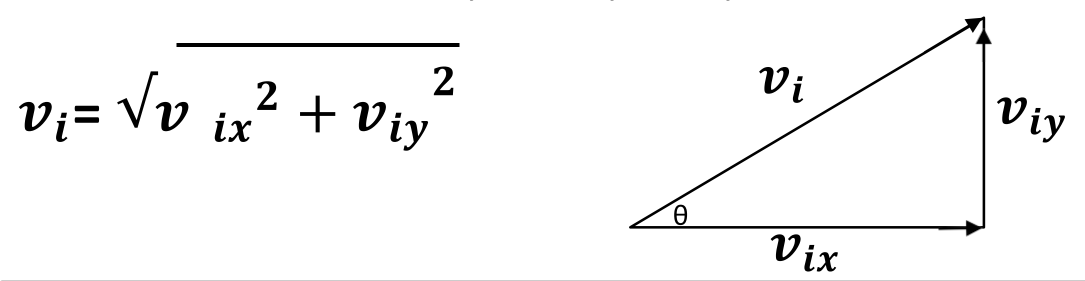
- The horizontal velocity can be determined from:

$$v_{ix} = v_i \cos\theta$$

- The vertical velocity can be determined from:

$$v_{iy} = v_i \sin\theta$$

- You can calculate velocity of body at any instant from:



$$v_i = \sqrt{v_{ix}^2 + v_{iy}^2}$$

Note: v_{ix} is constant so $v_{ix} = v_{fx}$

Horizontal velocity is uniform because $a_x = 0$

1) Finding the time of reaching maximum height (t):

$v_{fy} = v_{iy} + gt$, but at maximum height $v_{fy} = 0$

$\therefore \; -v_{iy} = gt$ so

$$t = \frac{-v_{iy}}{g}$$

2) Finding the flight time (T):

It's the time taken by the body from the initial point of motion till it returns back to the plane of projection, its double the time of reaching the maximum height.

$$T = 2\,t = \frac{-2\,v_{iy}}{g}$$

3) Finding the maximum height reached by the projectiles (h):

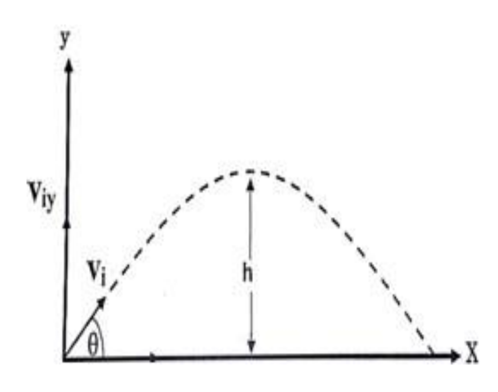
When the body reaches the maximum height , the velocity in the vertical direction vanished (v_{fy}=0)

$$2gd = {v_{fy}}^2 - {v_{iy}}^2$$

d is the distance we can state it (h) because we describing the height

$$2gh = 0 - {v_{iy}}^2$$

$$h = \frac{-{v_{iy}}^2}{2g}$$



4) Finding the horizontal range (the horizontal distance reached by the projectiles) (R):

∵ The time of maximum horizontal range = Flight time = **T**

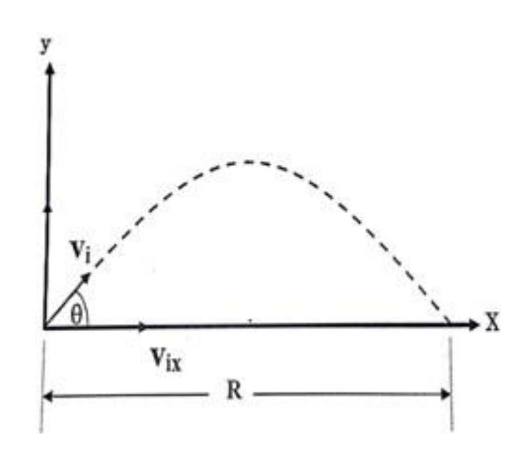
To find distance we can use 2nd equation $d = (v_{ix}\, t + \frac{1}{2}\, a\, t^2)$

in x-direction a_x = 0 and (**d** = **R**) in the second equation of motion so it will be:

$R = v_{ix} * T$

but T= 2t

and $t = \frac{-v_{iy}}{g}$ by substitutin

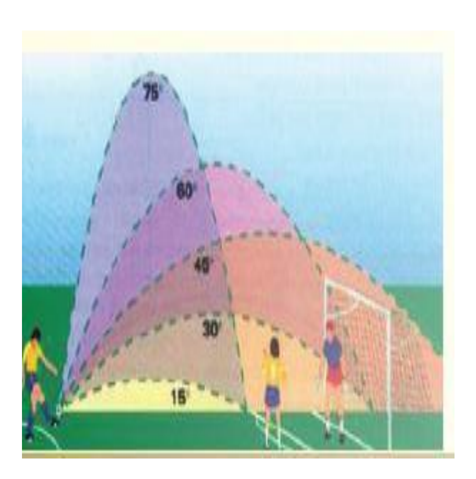


Miss\Menna Mohamed

$$R = v_{ix} * \frac{-2v_{iy}}{g}$$

Notes:

1)The projectile reaches its maximum horizontal range (R) When projected at an angle of 45° and the maximum height in this case equals $(\frac{R}{4})$.



2) The horizontal range of two objects is the same if they projected at complementary angles (their sum is 90°) and at the same initial velocity.

Example: A motorcycle is launched at a speed of 15 m/s in a direction that makes 30^0 with the horizontal. (g =10 m/s^2)

a) What is the maximum height reached by motorcycle?

b) How long does it fly?

C) What is the maximum horizontal range a bike can reach?

Solution: v_i= 15 m/s θ = 30° g = 10 m/s^2 Firstly I have to calculate v_{ix} and v_{iy}

$v_{ix} = v_i \cos\theta$ = 15 cos 30 = 12.99 m/s

$v_{iy} = v_i \sin\theta$ = 15 sin 30 = 7.5 m/s

a) The maximum height (h) = $\frac{-viy^2}{2g}$ = $\frac{-(7.5)^2}{2(-10)}$ = 2.8m

b) The time of the flight (T) = $\frac{-2\,v_{iy}}{g}$ = $\frac{-2\,(7.5)}{-10}$ = 1.5m

c) The horizontal range (R)

= v_{ix} $*$ **T =** 12.99 $*$1.5

=19.48m

Work sheet

Choose the correct answer

1)when the projectile which is projected at an angle reaches the same horizontal level after time T , then it reaches the maximum height after time ……………….

a)$1/2\,T$ **b)** T **c)** $2\,T$ **d)** $T/2$

2)the horizontal displacement reached by two identical projectiles is the same when they are projected at the same initial velocity from the same point at angles ………………………..

a)80˚ and 60˚ b)40˚ and 50 ˚ c)80 ˚ and 20˚ d)80˚ and 30˚

3)if an object is projected upwards at an angle of 30˚ to the horizontal and its initial velocity is 20 m/s , so the maximum height reached by the object is ……………………. (g=10m/s^2**)**

a)5 m b)10 m c)15 m d)20 m

4)a ball is projected from the earth's surface with velocity of 20 m/s at an angle of 60˚ to the horizontal , then

***the maximum height reached by the ball is ……………………….**

a)0.866 m b)5 m c)15 m d)30 m

***the maximum horizontal range reached by the ball when it returns to the earth's surface is ……………**

a)34.64 m/s b)38.5 m c)41.3 m d)60 m

5)an object is projected at an angle of 30˚ to the horizontal and returns to the earth's surface after 4 s , then :

***the initial velocity by which the object is projected equals ………………….**

a)60 m/s b)40 m/s c)35 m/s d)20 m/s

***the horizontal component of the object's velocity at the moment of the projection is ………………..**

a)30√3m/s b)20 √3 m/s c)10 √3m/s d)5 √3m/s

***the maximum height reached by the object is …………………………..**

a)45 m b)20 m c)5 m d)1.25 m

6)a cannon that is placed on the ground fires projectiles at an angle of 45 ˚ to the horizontal , so the initial velocity that is required for firing the projectiles to hit a target 1000 m away from the cannon is …………………………………………………………

a)150 m/s b)100 m/s c)75 m/s d)50 m/s

Chapter (3): Force and motion

Previously we have described motion by studying the conceptsof velocity and acceleration without getting into the reasons beyond.In this chapter we are going to discuss the existence of acceleration due to the impact of a force. This leads us to Newton's laws of motion that **are considered as basic laws inphysics.**

Force:

Is an external influence that affects the object to change its state or direction of motion (from rest to motion or vice versa.



Force is measured by the **spring balance** in Newton (N). **Examples:**

1-Your muscle strength helps you move bodies.

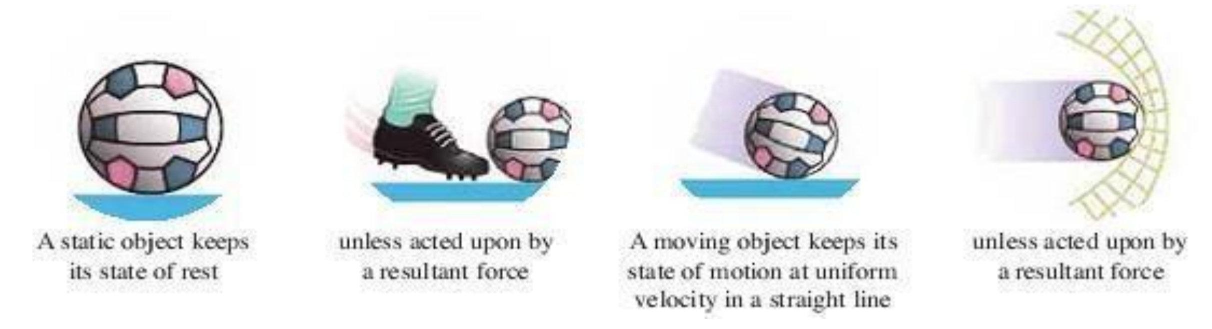
2-The Force of the car engine helps the car to start motion.3-Brakes force acts to stop the car.

1) Newton's first law:

A body keeps its state of (rest) or (motion at a uniform velocity in a straight line) unless acted upon by a resultantforce that changes its state.

The mathematical formula of the law is $\Sigma F = 0$

The symbol (Σ) pronounced sigma or summation it means the resultant force.



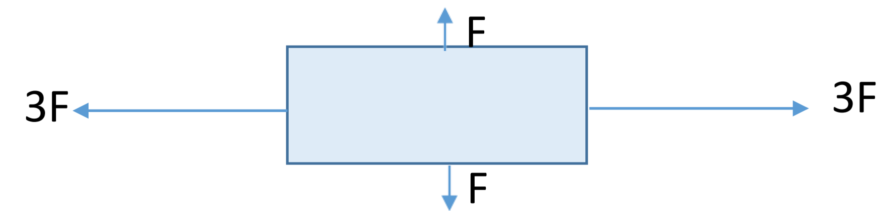
The term ΣF is the resultant force that may equal zero when the forces acting on an object may cancel the effect of each other.

Applying Newton's First Law, we can draw a conclusion that when the resultant force = 0, acceleration = 0, and no change happens in object velocity either being static or dynamic. Also, a resultant force is needed to move a static object or to stop a moving one. No need for a resultant force to move objects at uniform velocity in a straight line.

Give reasons ......?!!

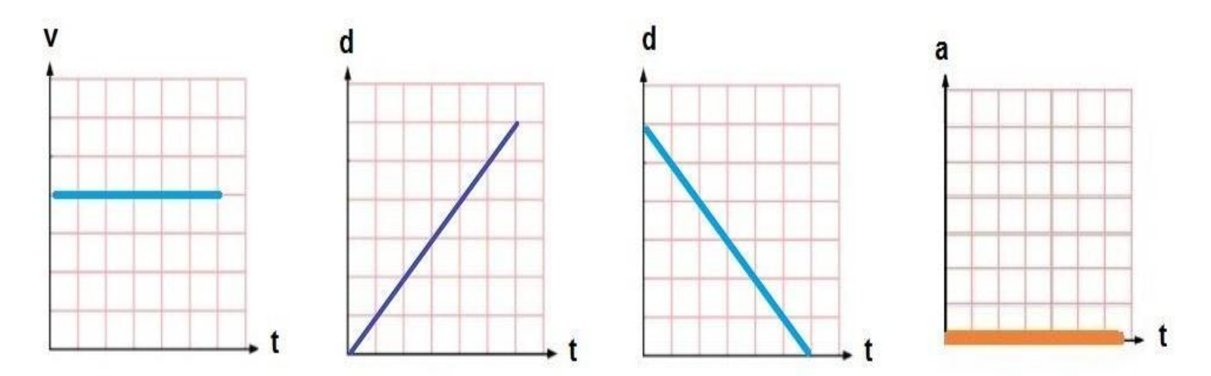
1- Two or more forces act on an object but its state didn'tchange?

Because the Resultant force on this body = zero



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Graphic relationships that apply to Newton's first law:



In all of the previous cases, the net force on the moving body = **zero** because objects are moving at a constant velocity, acceleration **(a) = zero**.

- Newton's first law is known as the law of **Inertia.Inertia:**

It's the tendency of an object to keep either its state of rest or state of motion at its original velocity uniformly in a straight line. This means that objects resist changing its static or dynamic state.

Or "it is the property of objects to resist the change of its static or dynamic state".

In the shown figure when a woman driving a car with a certain velocity and suddenly used the brakes so the car will stop but her body still in the motion state.



SO we can say

1- Newton's first law known as the law of inertia **because** the object **can't change** its state of rest or motion in straight line**by itself**.

2- Seatbelt should be **fastened** on driving to **stop inertia** during sudden stop and protect passengers from being hurt.

Technological applications:

When being away from the Earth's gravity, **a space rocket** does not need to consume fuel to keep moving because inertia keeps it moving at uniform velocity in a straight line.



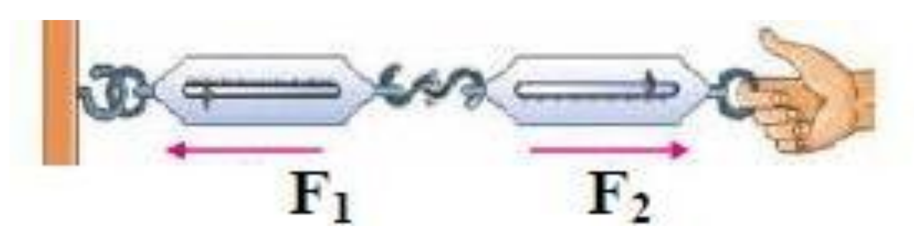
2) Newton's second law will be studied in the second term

3) Newton's Third law:

When an object acts on another object by a force, the second object reacts with an equal force on the first object in a direction opposite to that of action."

I.e. For every action there is a reaction **equal in magnitude** *and* ***opposite in direction***.

The mathematical formula that expresses the law: **F1= - F2**



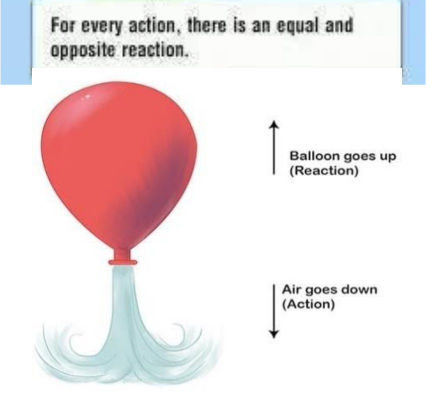
Examples:

1- When a man jumps from a boat to the reef (action), The boat shifts backwards (reaction).



2- When a bullet is fired (action) the rifle recoils backwards (reaction).so the soldier should mount the rifle back firmly to his shoulder.

3- When blowing up a balloon and leaving it free, the trapped air pushes out the open end (action),causing the balloon to move upwards (reaction)



Notes:

1- No single force can exist in the universe **because** action andreaction are paired forces; originate and vanished together.

2- Although they are equal, it's not a must that action and reaction are at equilibrium **because** the two forces acts on different bodies and equilibrium condition happens when thetwo forces act on the same body.

3- **Action and reaction** are of the same **type**; if the action is gravitational force the reaction is a gravitational force, as well.

Note:

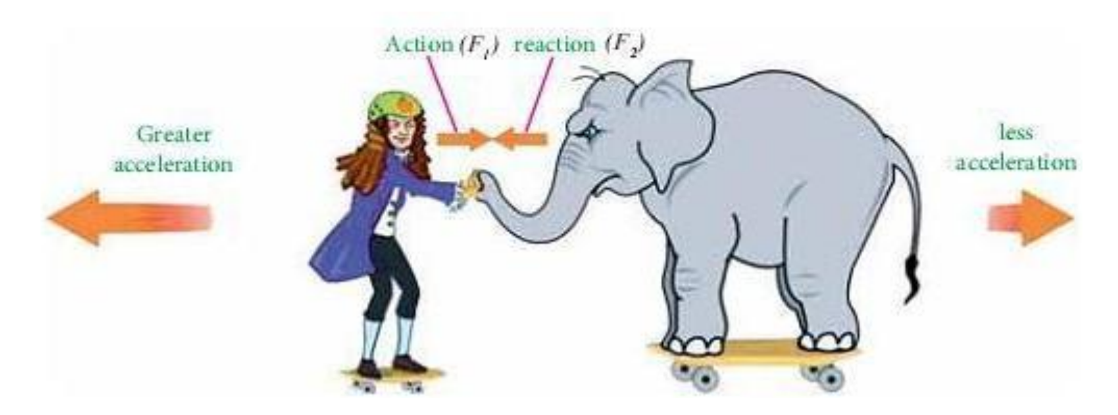
For two forces to be at **equilibrium**, they must be **equal**, **opposite**, **having one line of action** and **act on the samebody**.

Technological application

Launching a rocket is based on Newton's third law of motion. A huge amount of burning gases rush down the rocket to generate a reaction pushing the rocket upwards.

Example1:

Study the following figure, then answer the question below



1. What is the relation between the force acting on the elephant and that on the man?
2. Why the action on the elephant and reaction on the man are **not** at equilibrium?

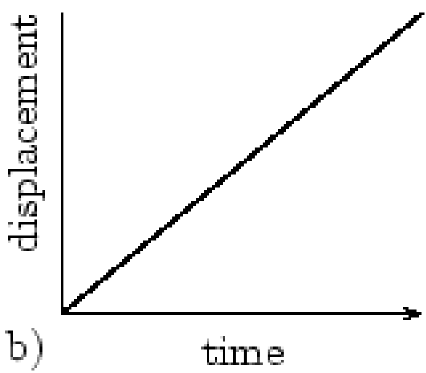
Solution:

1. The force acting on the elephant = the force acting on theman.
F1= -F2
2. For two forces to be at equilibrium, they must be equal, opposite, having one line of action and act on the same body. All these conditions except the last one may be applied on action and reaction; since the action acts on the elephant andthe reaction is on the man.

Work sheet

Choose the correct answer :

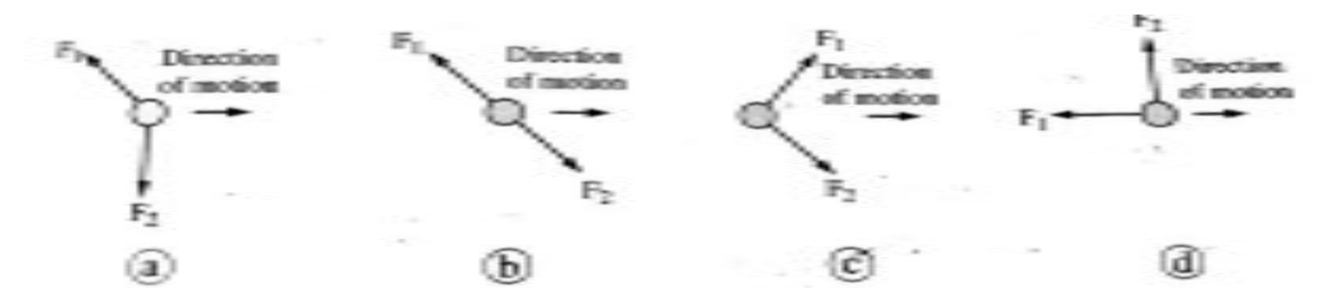
1)the opposite graph represents the relation between the displacement and time of a body of mass 10 kg that moves in straight line , so the



acting resulting force on the body equal ....

a)30 N b) 300 N c) 3 N d)0

2)which of the following figures represents a body that moves with a uniform velocity (v) under the effect of two equal forces in magnitude F_1 and F_2 ?



3)in the opposite figure , there are three spring balances that are in equilibrium state , if the reading of each of the first and the second balance is 100 N , so the reading of the third balance is ....

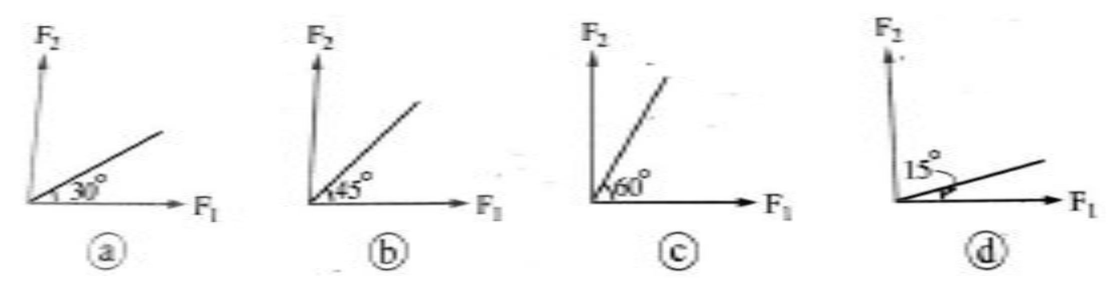


a)0 b)25 N c)50 N d)100 N

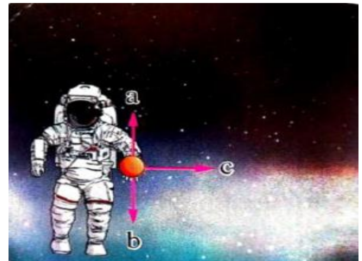
4)when blowing up a ballon and leaving it free , the ballon moves ....

a)in the direction of the air rush
b)in a direction right to the direction of the air rush
c)in the opposite direction of the air rush
d)in a direction left ti the direction of the air rush

5)which of the following graph represenst the relation between the magnitude of the reaction force $F2$
And the magnitude of the action $F1$ when drawn by the same drawing scale ?



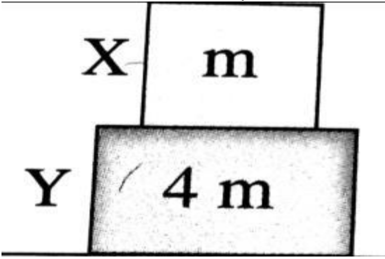
6)if an astronaut who is floating in the space projection a small object in the same direction of (a) as an opposite figure ,



the astronaut will ....
a)move in the direction of (a)
b) move in the direction of (b)
c) move in the direction of (c)
d)not move

7)if a body (x) acts on another body (y) by a force of 9 N , then the reaction force of a body (y) on body (x) equals
....
a) 1N b) -9 N c)0 d) 9 N

8) the opposite figure shows body (x) that is placed above body (y) and both of them are in rest . if body (x) acts on body (y) by a force of F downward , then body (y) acts on body (x) by a force ....



essay questions:

1)can a body be in a state of equilibrium when it is affected by a single force ?? explain .

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....

2)explain why car manufacturing companies have added safety belts to each car .

....
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....

3)mention the action nd reaction forces in each of the following cases :

a)a man moves in the street

b)a catches the football

c)a window is closed due to the wind blowing

a)..
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b)..
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c)..
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